Pacific Fisheries Resource Conservation Council
Conseil pour la conservation des ressources halieutiques du pacifique

Annual Report

2001 - 2002

ERRATUM

Printing and Editorial Corrections for the PFRCC Annual Report 2001-2002 released

October 17, 2002

With our apologies, staff of the PFRCC have identified printing and editorial errors in the recently released Annual Report. This text identifies the corrections to be made and provides two properly printed figures.

Figures: Due to printing in black-and-white only, two figures used texture in the plots to represent categories or data types. However, the textures did not print correctly in Figure 2.3 (page 11, Fraser sockeye section) and Figure 5.2 (page 61, WCVI sockeye section). The correctly presented figures are attached on separate pages of this Erratum.

Table: Table 5.3 (page 69, WCVI pink section) is correct in the text, but references to Departmental statistical areas were left in the table. These references were to be replaced by location names for each river. An edited table is also attached to this file if you choose to edit/replace the table.

Text corrections:

Page 43, end of the 14th line: Table 2 should be Table 4.3

Page 55, end of paragraph: insert a reference to (Figure 4.21).

Page 63, 3rd row of table: "Kyuguot" should be spelled "Kyuquot"

Page 66, 2nd paragraph, 7th line: insert "but" before "frequency"

Page 67, end of 1st paragraph, 1st line: insert a reference to (Figure 5.5).

Page 74, 2nd line of Coho section: change Table 5.6 to Table **5.7**

Page 76, last line, 2nd paragraph, **correction**: change "… released in 1994 (Figure 5.13)." to "… released from the 1994 spawning year (Figure 5.13)."

Page 79, 1st line, 3rd paragraph: change Table 5.6 to Table **5.8**

Page 79, 1st line, 4th paragraph: change Figure 4.16 to Figure **5.16**

Page 80, 2nd line, centre paragraph: change Figure 4.17 to Figure **5.17**

Page 81, 3rd last line, top paragraph: delete in
Page 81, last line, top paragraph: change Figure 4.18 to Figure **5.18**

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Pacific Fisheries Resource Conservation Council

Annual Report 2001-2002

PACIFIC FISHERIES RESOURCE CONSERVATION COUNCIL
CONSEIL POUR LA CONSERVATION DES RESSOURCES HALIEUTIQUES DU PACIFIQUE

October 2002

Hon. Robert Thibault
Minister, Fisheries and Oceans
Government of Canada
Ottawa

Hon. John van Dongen
Minister of Agriculture, Fisheries and Food
Government of British Columbia
Victoria

Dear Ministers:

As Chair of the Pacific Fisheries Resource Conservation Council, I am transmitting this fourth annual report to you and all British Columbians. It provides an overview of the status of salmon stocks in the southern area of the province, and it identifies some pressing conservation issues, including mortality of late-run Fraser River sockeye and loss of stock monitoring capacity.

This annual report fulfills part of the Council's mandate to provide strategic advice to you and your ministerial colleagues and to the public on the conservation and long-term sustainable use of Pacific salmon stocks and their freshwater and ocean habitat in British Columbia. Its analysis, observations and recommendations are consistent with the guiding principles adopted by the Council that relate to:

- promoting public accountability in the conservation of fish populations and their ecosystems;
- obtaining and communicating objective information on the state of fisheries resources; and,
- encouraging an ecosystem approach to fisheries management, responsible stewardship of marine resources and fish habitat, and public awareness of the importance of biological diversity and sustainable fisheries practices.

This report contains more comprehensive information and analysis than we produced in the past. The Council members, urged by stakeholders, determined that a more detailed stock-specific and geographic perspective would be more valuable than an overview. Consequently, this report concentrates on southern regions: the Fraser River, Okanagan, Strait of Georgia and West Coast of Vancouver Island. An upcoming report of the Council, possibly our next annual report in Spring 2003, will provide a similar level of information regarding the central and northern regions.

The cooperation of staff from the Pacific Salmon Commission and Fisheries & Oceans Canada was instrumental in furnishing the data, stock performance indicators and maps that underpin this report's contents and analysis. The Council's production of this report enables public access to stock status information that is collected by governments, but not otherwise made readily available.

In previous annual reports, the Council recommended improvements in stock conservation and assessment, and in habitat protection and restoration. In our view, there has been progress in some instances. For stock conservation and assessment, there were advances last year in government policy consultations and in initiatives that tested new fisheries methods. At the same time, not enough has been done to advance the state of knowledge in the measurement of stock status and assessment

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of salmon productivity. In habitat protection and restoration, British Columbia may be continuing to lose its capacity to maintain the water quantity and quality conditions essential for salmon, and to provide sufficient safeguards and resources for salmon recovery.

The Council has consistently urged the Government of Canada to stay the course in maintaining regulations to protect and rebuild coho populations. A continuation of the restrictions is essential until a coho recovery is firmly demonstrated and stocks are fully replenished. We are pleased to note the improving condition of coho salmon in southern BC resulting from improved ocean conditions and conservation actions taken to date.

The Council's concerns about Fraser River sockeye have deepened as environmental and water problems have become more apparent and persistent. The late-run sockeye, including the Adams River stock, may be entering the Fraser River earlier than normal and are at severe risk from parasite-related mortality triggered by unknown causes. During the past year, the Council has advocated that more scientific work be initiated to determine the cause of the problem.

My fellow members of the Council – Mark Angelo, Mary-Sue Atkinson, Frank Brown, Murray Chatwin, Merrill Fearon, Paul LeBlond, Jeff Marliave, Marcel Shepert, Richard Beamish (ex-officio) and Carl Walters – join with me in urging you to take immediate action to address the issues we are highlighting in this report. The term of Fred Fortier as an ex-officio member of the Council representing the BC Aboriginal Fisheries Commission was completed last year, and we welcome Arnie Narcisse who was selected for the position.

A precautionary approach and vigilant management of the salmon and steelhead resource must continue to be foremost objectives for governments, community groups and individual British Columbians.

Yours sincerely,

Hon. John A. Fraser
Chairman

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Executive Summary

This annual report presents a comprehensive, factual account of the Pacific salmon stocks in southern BC and the Okanagan River, and the trends in their abundance and diversity. Subsequent Council reports will address Pacific salmon in central and northern BC and the transboundary rivers including the Yukon River, as well as steelhead stocks and salmon habitats. The purpose is to maintain this series on the Council's website and update the information periodically in order to present concise, informative texts that are readable and available to anyone in a timely manner.

This report is innovative in assembling information that is not otherwise available to the public in any other publication. It considers Pacific salmon in four regions of southern BC: Fraser River basin; Okanagan; Strait of Georgia; and West Coast of Vancouver Island. For each region and species, the report summarizes trends in spawning population sizes since the early 1950s, explains the annual monitoring of these populations, and identifies conservation concerns. The summarization of this extensive information has been a challenging task, and the Council welcomes feedback on the balance of material presented and suggestions for future revisions. This report also presents a brief follow-up to the issues raised in past Council reports.

A rich diversity and abundance of Pacific salmon populations continue to exist in many locations. More favourable ocean conditions have recently contributed to improved salmon production, and conservation measures implemented have also been crucial factors in recovery, particularly for southern BC coho.

Public access to information about salmon stocks and habitat has been improving, and both levels of government have taken steps to make their information more readily available to stakeholders and the public.

The Council believes that there can be a viable and productive future for Pacific salmon in southern BC and the Okanagan, but attention must be paid to protecting habitat and ensuring an empirical basis for stock assessment, management and enforcement decisions. A broad fisheries resource base remains, but despite recent improvements in spawning escapement, levels of production in most cases continue to be substantially below those of the past. These recent improvements cannot give rise to complacency about future conditions. Habitat restoration and stock conservation measures will continue to be required.

The task of rebuilding Okanagan sockeye production and restoring one of Canada's most disturbed ecosystems will be long-term and costly. There is an immediate need for annual monitoring and research into the factors limiting the region's production of sockeye salmon, and establishing the institutional arrangements to enable the stakeholders to work effectively together.

In their review of the state of salmon stocks, the Council members note that they often had little confidence in the data that was being provided. The Council strongly recommends that the continuing issue of questionable accuracy of the annual spawning escapement surveys must be addressed. Not every stream needs to be surveyed every year, but consistent and repeatable surveys conducted within an overall sampling design are essential for responsible monitoring and management. Recognizing the reality of funding limitations, new approaches and partnerships must be developed.

Another recommendation is for an evaluation of the role of salmon hatchery production and its consequences for the management and conservation of wild Pacific salmon. Despite the high levels of production of juvenile salmon in hatcheries, recent years have clearly demonstrated that an overall increase of harvestable salmon may not result. The latter heightens concern about the interactions of hatchery and naturally produced salmons and the sustainability of wild salmon in some areas of BC.

The Council continues to recommend a precautionary approach to management of coho salmon fisheries in southern BC until production from these stocks fully recovers. The Council noted the improving condition of coho salmon in southern BC resulting from improved ocean conditions and conservation actions taken to date.

The Council's profound concern about the Late-run Fraser River sockeye salmon, including the Adams River and Cultus Lake runs, leads it to suggest that this is becoming a severe salmon conservation problem in BC. The Council expresses support for the fishing restrictions during 2002 to preserve this important salmon run. At the same time, the limited research program and subsequent suspension of some recommended studies is recognized as an impediment to the achievement of any solution.

In repeating the views expressed in past reports where problems remain outstanding, the Council comments on ocean production factors, habitat issues, community involvement and community advisors, wild salmon policy implementation, and approaches to resource management. The wild salmon policy remains a focus of the Council's interest, as are the budget cuts in the BC Government and Fisheries & Oceans Canada and their impacts on information collection, stock assessment, public volunteer programs, and enforcement.

Sommaire

Ce rapport annuel est un compte rendu circonstancié de l'état des stocks de saumon du Pacifique dans le Sud de la Colombie-Britannique et dans la région de la rivière Okanagan, notamment au plan de leur abondance et de leur diversité. Il sera suivi par d'autres rapports analogues concernant les stocks du Centre et du Nord de la province et ceux des cours d'eau transfrontaliers, notamment le fleuve Yukon, ainsi que de rapports sur les stocks de saumon arc-en-ciel et l'état de l'habitat salmonicole. En publiant ces documents sur le site web du Conseil, nous voulons offrir une information à jour, concise et instructive, qui soit à la portée de tous.

L'information contenue dans ce rapport est inédite et porte sur quatre régions du Sud de la Colombie-Britannique, soit celles du bassin du Fraser, de l'Okanagan, du détroit de Georgia et de la côte Ouest de l'île de Vancouver. Elle résume les tendances démographiques observées depuis les années 1950 selon chaque région et chaque espèce, et décrit les activités de surveillance annuelle dont font l'objet ces populations de poissons ainsi que les problèmes de conservation auxquels elles font face. La compilation de cette importante quantité de données n'a pas été tâche facile, et le Conseil sera heureux d'avoir votre opinion sur l'information qui est présentée ici afin d'améliorer les éditions subséquentes. On trouvera également un bref suivi des questions soulevées dans les rapports antérieurs.

Il continue d'exister une grande diversité et une grande abondance de saumons dans plusieurs régions de la Colombie-Britannique. Les bonnes conditions marines qui ont prévalu récemment ont contribué à améliorer la productivité du saumon, et les mesures de conservation qui ont été mises en œuvre ont grandement contribué la récupération des stocks, en particulier celles des stocks de coho du Sud de la Colombie-Britannique.

L'accès à l'information concernant les stocks et les habitats du saumon par divers les groupes d'intérêt et le public a été amélioré grâce au efforts des gouvernements provincial et fédéral.

Le Conseil croit qu'il peut y avoir un avenir viable et productif pour les stocks de saumon du Sud de la Colombie-Britannique et de l'Okanagan, mais qu'il faut porter une attention particulière à la protection de l'habitat et à l'établissement d'une solide base empirique pour l'évaluation et la gestion des stocks, et le contrôle de la conformité. La ressource continue d'être importante, mais malgré les améliorations récentes observées dans le nombre de géniteurs, les niveaux de productivité sont dans l'ensemble considérablement inférieurs à ceux du passé. Les récentes améliorations observées ne doivent cependant pas nous rassurer outre mesure sur ce que nous réserve l'avenir et il faudra continuer de prendre des mesures pour restaurer l'habitat et conserver les stocks.

Les actions de rétablissement de la productivité des stocks de saumons rouges de l'Okanagan et la restauration de l'un des écosystèmes les plus perturbés du Canada promettent d'être longues et coûteuses. Il faut dès maintenant surveiller et étudier les facteurs qui limitent la productivité des stocks de saumons rouges de cette région, et prendre des mesures institutionnelles qui permettront aux groupes d'intérêt de travailler ensemble efficacement.

Dans leur examen de l'état des stocks de saumon, les membres du Conseil ont noté qu'ils avaient souvent raison de douter des données qui leur étaient fournies. Le Conseil recommande fortement qu'on se penche sur le continuel problème du manque d'exactitude des estimés de géniteurs obtenus lors campagnes de recensement annuelles. Il ne s'agit pas de recenser chaque cours d'eau, mais de procéder à des recensements systématiques et reproductibles sur un ensemble représentatif, afin d'établir un régime de surveillance et de gestion responsable. Tout en tenant compte des contraintes de financement auxquelles nous faisons face, il faut développer de nouvelles approches et de nouveaux partenariats.

Une autre recommandation qui a été faite consiste à évaluer le rôle de la productivité des piscicultures et son incidence sur la gestion et la conservation des stocks de saumons sauvages. Malgré les taux de productivité élevés des saumons juvéniles issus de piscicultures, l'expérience récente a montré que ces taux ne se traduisaient pas nécessairement par une augmentation générale des effectifs exploitables. Ce facteur met en lumière le problème que suscite l'interaction entre spécimens naturels et spécimens d'élevage et la viabilité des salmonicultures dans certaines régions de la Colombie-Britannique.

Le Conseil continue de recommander l'adoption d'une politique de précaution dans la gestion des stocks de coho du Sud de la Colombie-Britannique, d'ici à ce que les effectifs se soient complètement rétablis. Le Conseil a noté l'amélioration de l'état des stocks de coho dans le Sud de la Colombie-Britannique grâce à l'amélioration des conditions océaniques ainsi que des actions de conservation prises à ce jour.

Les graves préoccupations suscitées par les remontées tardives de saumon rouge dans la Fraser, notamment les remontées dans la rivière Adams et dans le lac Cultus, nous incitent à penser que cette situation est en train de devenir un sérieux problème de conservation. Le Conseil souscrit aux restrictions de pêche prises pour l'année 2002 afin de préserver ces importantes remontées. Dans le même temps, le programme de recherche limité et la suspension de certaines études qui avaient été recommandées constituent une entrave à la mise en œuvre de quelque solution que ce soit.

Le Conseil réitère les points de vue formulés lors des rapports précédents concernant les problèmes qui restent irrésolus, en mentionnant les facteurs associés à la productivité marine, à la perturbation de l'habitat, à la mobilisation communautaire, à la mise en œuvre d'une politique concernant le saumon sauvage, et aux méthodes de gestion de la ressource. La politique à adopter concernant le saumon sauvage demeure l'un des principaux sujets d'intérêt du Conseil, de même que les compressions budgétaires imposées par le gouvernement de la Colombie-Britannique et Pêches et Océans Canada et leur impact sur la collecte des données, l'évaluation des stocks, les programmes de bénévolat et le contrôle de la conformité.

1. Introduction

Each year, the Pacific Fisheries Resource Conservation Council reviews the conditions of salmon stocks and habitats in British Columbia, and offers comments and advice on the ways to ensure long-term sustainability. The Council's December 2001 report focused on a coast-wide perspective of salmon production associated with recent changes in the marine environment. By contrast, this report is the Council's first step towards providing a more in-depth description of the Pacific salmon resource, its current state, and the ability to assess and understand this important resource. Until now, such a descriptive report has not existed.

There are thousands of Pacific salmon populations in British Columbia and the Yukon. The Council's challenge has been to summarize the available material into informative, but concise, text that can be used by all interested parties and the public for future reference. This report is the first of the Council's planned series of four publications describing the salmon resource in southern BC, central and northern areas plus the Yukon, steelhead stocks, and salmon habitat. This first report is limited to the southern region of the province, including the Okanagan watershed. The information is derived primarily from escapement records of Fisheries & Oceans Canada, reports of the Pacific Scientific Advice Review Committee (PSARC), and published references.

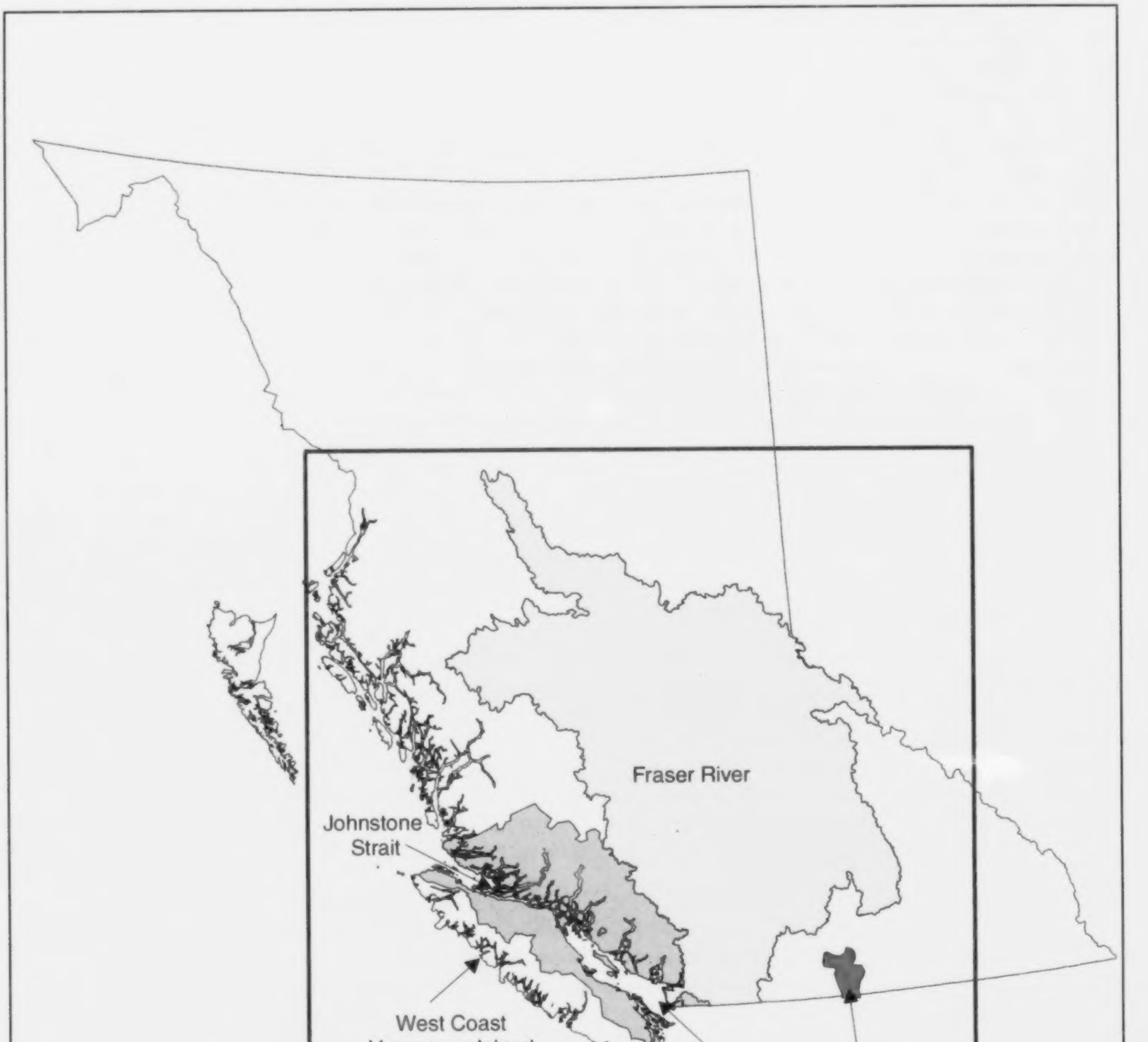
In developing this report, the Council has attempted to present a balance of comments and observations that include the details of the resource base, the salmon stock status today compared to past years, and the management and assessment of these populations. In recent years, the focus of public attention on salmon has frequently been on current short-term production problems, poor survival due to ocean conditions, and generally negative circumstances and trends.

Salmon are threatened by continued economic development, climate change, and human population growth. At the same time, the salmon are diverse, highly dynamic, and resilient. An objective review of the salmon resource should consider the breadth of these populations and present a long-term perspective, while identifying the immediate problems to be addressed. The Council expects that this series of reports will be evolving documents that can incorporate new information as it becomes available and identify conservation issues as they develop. The Council's website provides the medium that will be used to maintain and update these documents.

This report includes four chapters on stock status, addressing Pacific salmon conditions in the Fraser River basin, Okanagan River, streams adjacent to the Strait of Georgia and Johnstone Strait, and the West Coast of Vancouver Island (Map 1). The stock information presented here is not available at this level of detail in any other publication, and the Council has determined that it will continue to fill this void in the future.

Other chapters of the report present brief updates on the views and advice expressed in past Council reports. There is less emphasis than in the past on habitat conditions and issues as they relate to Pacific salmon. The on-going series of budget cuts, sunsetting of programs, and personnel reductions in fisheries management at both senior levels of government give cause for apprehension about the actual capacity of governments to apply and enforce provisions of the Fisheries Act and other relevant fish protection legislation. The extent to which these changes may affect the levels of habitat protection and government investment in stream restoration, for example, will be a primary subject of the Council's investigation and advice during the coming year.

Map 1: Southern BC Region



2. Fraser River Salmon

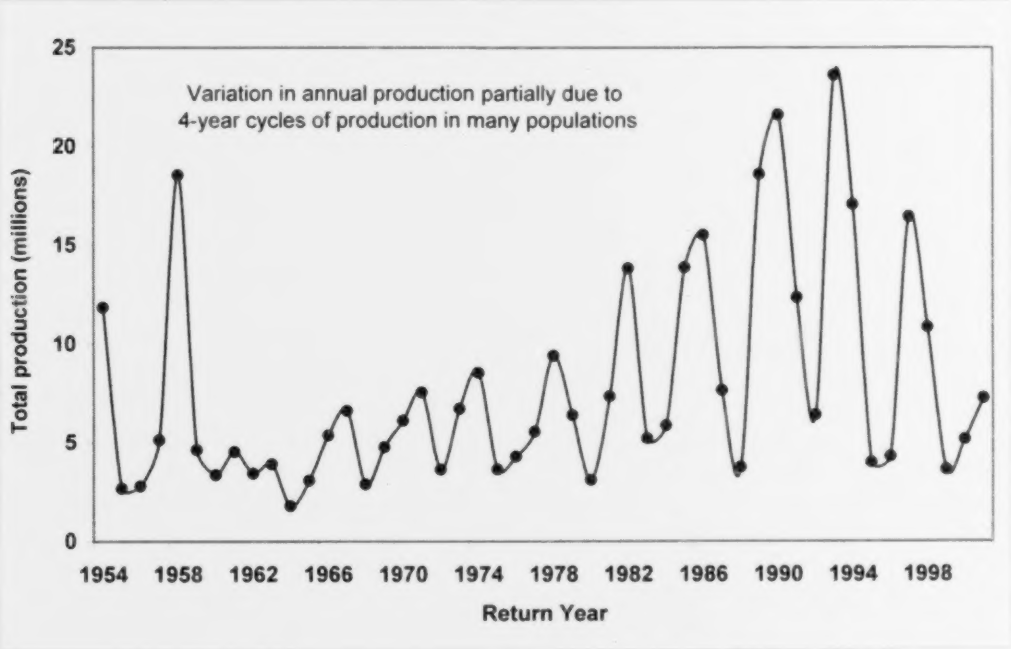
The Fraser River is the largest river and salmon producer in British Columbia. Its watershed is extensively developed for agriculture and other industries, and it contains most of the province's human population. Salmon production is vulnerable to this intensive activity, impact of changes in water quality and quantity, as well as extensive harvesting. The watershed is also the southern-most extent of major sockeye production and in the southern range for pink and chum salmon. Consequently, environmental changes due to local habitat impacts and global climate effects are likely to affect salmon production in this system.

Overall, returns during 2001 indicate that the status of many salmon stocks in the Fraser basin is improving, but there continue to be noteworthy concerns. This chapter considers each salmon species within the Fraser River and comments on its conservation issues.

2.1 Fraser River Sockeye

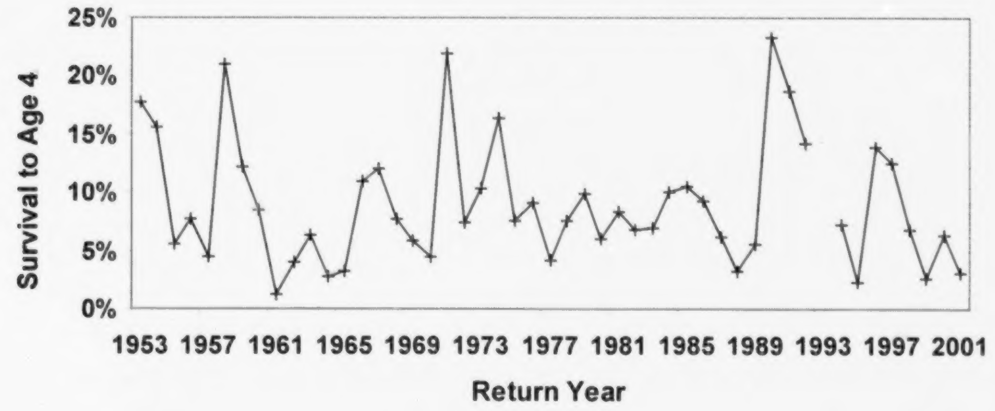
In 2001, Fraser sockeye returns generally improved relative to the two preceding years, but total production for the 2001 cycle remained depressed (Figure 2.1). The fish were in good condition in the ocean and more of them migrated through Juan de Fuca Strait, suggesting improved ocean conditions.

***Figure 2.1**. Total production (catch plus spawners) of Fraser River sockeye salmon, 1954-2001 annual returns (data provided by the Pacific Salmon Commission).*



The limited production of sockeye in 2001 relative to recent past levels was also reflected in terms of the pre-season forecasts of adult returns. Predictions of future Fraser sockeye production are largely based on the numbers of parents in the spawning year and the historical relationship between numbers of parents and estimated production of progeny (i.e., the rate of production or productivity). These relationships assume stable environmental conditions each year, and apply the averaged rate of production for each population. However, the total return in 2001 (7.26 million sockeye) was far below the pre-season forecasted return (i.e., the rate of production in populations returning in 2001 was only 56% of past average rates). This relatively poor rate of return is consistent with observations for the only sockeye population within the Fraser basin for which the marine survival can be directly estimated. Returns of Chilko Lake sockeye in 2001 indicated poor survival compared to past years (Figure 2.2).

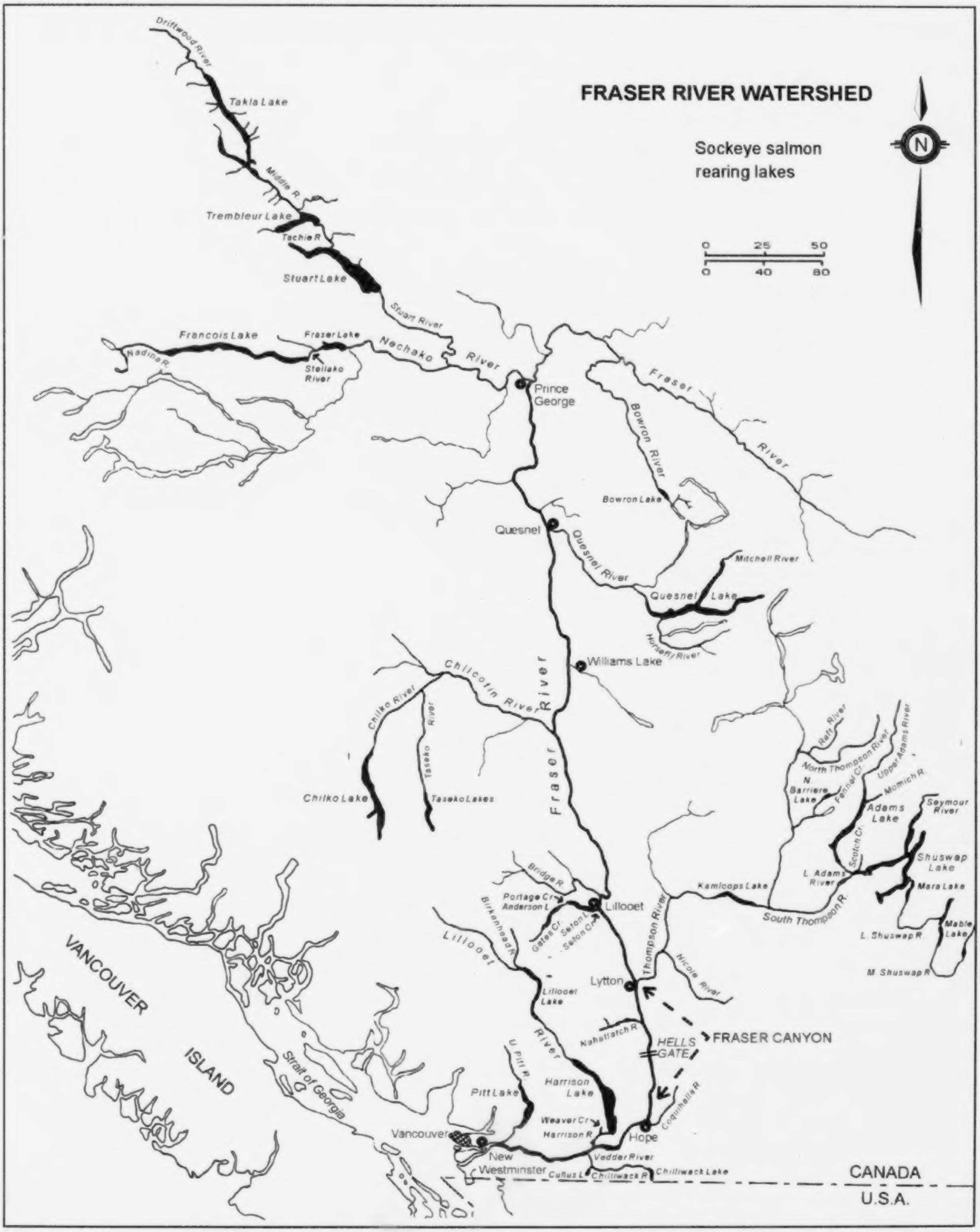
Figure 2.2. *Estimated survival rate (%) of sockeye smolts emigrating from Chilko Lake and returning as Age-4 adults. Smolts emigrating from Chilko Lake are estimated past a weir and Age-4 Chilko adults are estimated in catches and on the spawning grounds.*



Forecasts of salmon abundance are generally uncertain, and forecasts are now presented as a range of return values based on the expected return value (i.e., the averaged rate of production by population) and deviations observed from past forecasts. A forecast value may then be predicted for a specific probability level that the return will be greater than or less than the forecast. Forecasts for the 2001 Fraser sockeye were presented in the PSARC, Proceedings Series 2001/04. For example, if a value is listed under the '75%' column, this means that past data indicates that we are 75% confident that the abundance of sockeye returning will equal or exceed the table value. But it also acknowledges that there is a 25% risk that the return will be smaller.

Given the recent uncertainty about the effect of ocean conditions, forecasts for 2001 sockeye returns were reasonable, with the exception of Early Stuart returns that were substantially over-estimated (Table 2.1). For management purposes, individual sockeye populations are grouped into aggregates that have similar migration timing (i.e., returning to coastal waters and migration into the Fraser River). For reference purposes, Schubert (1998) provides an excellent summary of the run timing groups, run timing definitions, and the individual spawning populations aggregated within each.

Map 2: Fraser River Basin



Sockeye salmon spawning grounds in the Fraser River watershed.

Map provided by The Pacific Salmon Commission

***Table 2.1**. Observed return of Fraser sockeye salmon in 2001 by management stock groups and compared to the 2001 pre-season forecasts of abundance (PSARC Proc. Series 2001/04). Highlighted table entries are levels of forecasts that were closest to the observed 2001 return.*

Stock Group	2001 Observed Return	Probability of Achieving Specified Run Sizes			
		25%	50%	75%	90%
Early Runs	212,252	682,000	420,000	**258,000**	**167,000**
Early Summer	385,769	**392,000**	202,000	107,000	61,000
Summers	6,113,917	22,560,000	11,714,000	**6,159,000**	3,489,000
Late Summer	544,356	1,026,000	**528,000**	273,000	152,000
Total	7,256,294	24,660,000	12,864,000	**6,797,000**	3,869,000

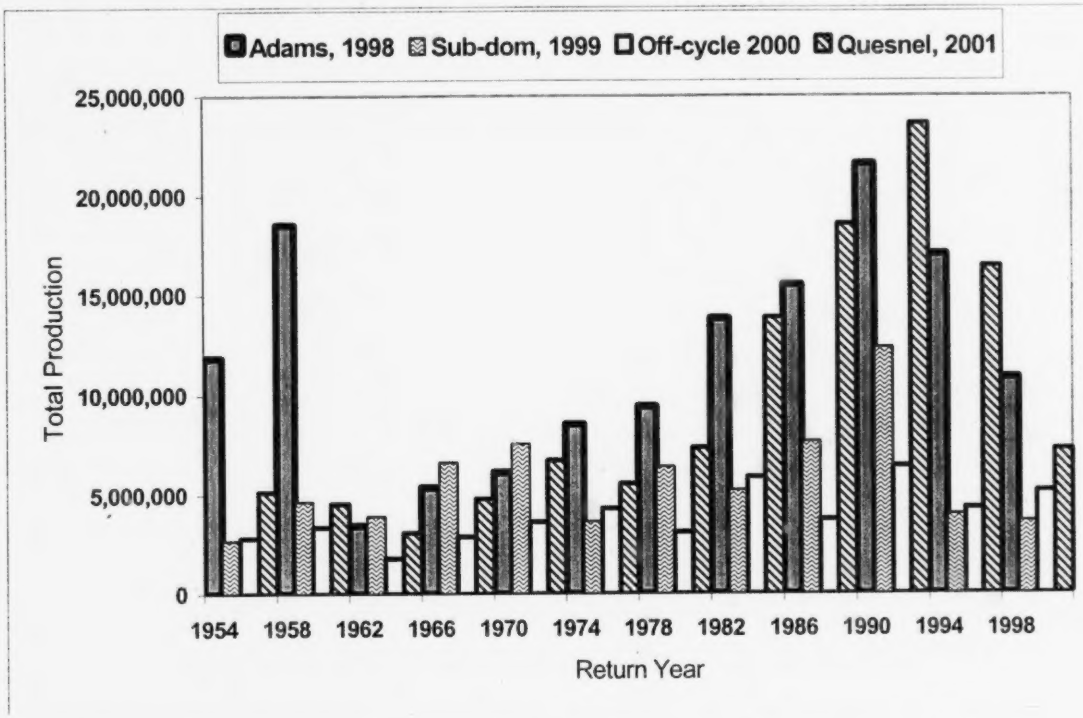
Schubert's summary of run timing groups should be noted:

> *The Early Run, commonly termed the Early Stuart Run, consists of 32 stocks which spawn in the Stuart River system; the run arrives in the lower Fraser River from late June to late July. The Early Summer run, which consists of 34 stocks which spawn throughout the Fraser system, arrives in the river from mid-July to mid-August. The Summer Run, which consists of 33 stocks which spawn in the Chilko, Quesnel, Stellako, and Stuart systems, arrives in the river from mid July to early September. The Late (summer) Run, which consists of 52 stocks which spawn in the lower Fraser, Harrison-Lillooet, Thompson, and Seton-Anderson systems, arrives in the river from August to mid October. (pg. 3, Schubert 1998)*

This description refers to 151 individual spawning populations of sockeye salmon within the Fraser River (Map 2). The Council has not yet conducted a full assessment of individual populations through 2001 returns, but did examine 30 populations in a database maintained by the Fraser Panel staff of the Pacific Salmon Commission. Appendix 1 of this report identifies the 30 populations, their run-timing category and geographic location, and comments on their status through 2001. Their recent status was considered relative to the full time series of available data. Appendix 1 indicates increasing production in ten stocks, no long-term change in seven, decreasing production in seven, and unknown trend status for six. Examples of the long-term production trends for eight populations are presented graphically in Appendix 2.

In most Fraser sockeye populations, the level of production varies in regular cycles which is a feature referred to as cyclic dominance. The biological basis of these cycles is not well understood but the period of the cycles is four years because most Fraser sockeye mature at age four (generally one year in freshwater followed by three years at sea). When production is summed over all the stocks returning in one year, the effect of cyclic dominance has been a pattern of: one cycle year of strong production (Adams cycle 1954-2002 years); a cycle of increasing production (Quesnel cycle 1953-2001 years); a "sub-dominant" cycle of moderate production that follows the Adams cycle (1955-1999); and one year of generally poor production ("off-cycle" years, 1956-2000). It is noteworthy that 1999 and 2000 returns of Fraser sockeye have frequently and publicly been noted as being abnormally poor production and evidence of concern for Fraser sockeye stocks. Compared to past years, though, the Council's assessment may be quite different, as Figure 2.3 indicates.

Figure 2.3. *Total production of Fraser sockeye salmon by cycle year (1954-2001).*



Returns in 2000 were, for example, typical of the "off-cycle" production. Returns in 1999 reflected a significant reduction in production in the "sub-dominant" cycle, but this change actually occurred in the previous cycle-year (1995). The strongest evidence for a loss of production is likely the 2001 return. How is this statement consistent with our comments above that most populations (17 of 30 populations in Appendix 1) are not showing evidence of declining production? The explanation relates to the time scale of these comparisons. In the past few years, production may have declined, but compared to longer time periods most Fraser sockeye populations are relatively healthy in terms of abundance. The examples presented in Appendix 2 portray this point. Each graph presents the historical estimates of the catch plus spawning escapements (i.e., total annual production) in each year of return for the time series available, and the 2002 forecast prepared by Fisheries & Oceans Canada (see PSARC Proc. Series 2001/030). Each 2002 forecast is presented as two circles indicating the 25% and 75% range about the expected total production. The eight stocks presented for 2002 include the major summer ones (Horsefly River, Chilko Lake, Late-Stuart), the Early Stuart and Gates (early summer), and three Late-run stocks of concern (Adams, Weaver, and Cultus Lake). They also include some of significant conservation concern, notably the Early Stuart and Cultus Lake, and the loss of production observed in the 2001 cycle line for the Late Stuart stock (denoted by dashed-line circles in these figures).

It is also important to note that consideration of total production within aggregates (either a cycle year or a run-timing group) hides two important considerations for the conservation of salmon. Within the total production, how many sockeye reproduced effectively? And, within an aggregate, how were the numbers of spawners distributed between individual spawning sites?

Fisheries & Oceans Canada maintains spawning escapement records by spawning site and, as noted previously, the Council has not yet examined each individual population. However, the issue of effective spawners is a very important issue at this time. Since the mid 1990s, many of the Late-run sockeye returning to the Fraser River are dying before they spawn and their status is poorer than indicated by these reported total returns.

The Late-run Fraser Sockeye Problem

The essential issue is dramatic change in the behaviour of migrating late-run sockeye. Late-run sockeye normally return to coastal waters in August and move up-river during September. These Late-run sockeye are unusual in that they normally delay migration at the mouth of the Fraser River for about 4-6 weeks before moving up stream. There is no direct evidence for why they delay but biologists have inferred that this is related to the temperature of their lake environments and the need to balance the stress of the up-stream migration with the timing of successful spawning.

In recent years, however, late-run sockeye stocks are not holding outside of the Fraser River and are migrating up-river much earlier than in the past. Consequently, the time between entry into freshwater and when they typically spawn has become much longer, leading to very high mortality rates (observed in recent years over 90%), before spawning. Information provided by the Pacific Salmon Commission demonstrates that as these sockeye migrate earlier, the mortality rate before spawning has increased dramatically (see Figures 2.4 and 2.5). Their reproductive potential also decreases dramatically and over the next few generations this trend will put these valuable sockeye at risk of extinction. In the meantime, this will entail a severe loss of production and economic value, as well as loss of ecological and cultural values. These late-run Fraser sockeye include the famous lower Adams River population that has been described as one of the "Wonders of the World" and every four years is the focus of major educational and communication programs.

Conservation concerns for these stocks also lead to fishery management issues for other stocks that overlap in their migration timing (Figure 2.6). The figure below shows the "typical" run timing of the major stock groups of Fraser River sockeye salmon and how the Late-run sockeye overlap extensively with the Summer sockeye in the outer Strait of Juan de Fuca fishing area. This timing overlap compounds the potential economic impact of the late-run problem since any fishing on the Summers sockeye will also impact the late-run sockeye. During the summer of 2002, significant resources were directed to study how to manage this overlap in run timing. While some resources have been devoted to the relation between mortality rates and the timing of the sockeye return to coastal waters and up-stream migration, the Council is on record of recommending that more research effort needs to be devoted to understanding the causation of the problem. Furthermore, to provide for harvest of the Summer-runs sockeye and protect the Late-run sockeye during 2002, Fisheries & Oceans Canada and user groups have agreed to limit the total mortality on Late-run sockeye to 15% mortality during fisheries directed to harvest Summer-run stocks.

***Figure 2.4**. Pre-spawning mortality rate (percentage of estimated spawning escapement) observed in recent years for the Lower Adams River late-run sockeye salmon.*

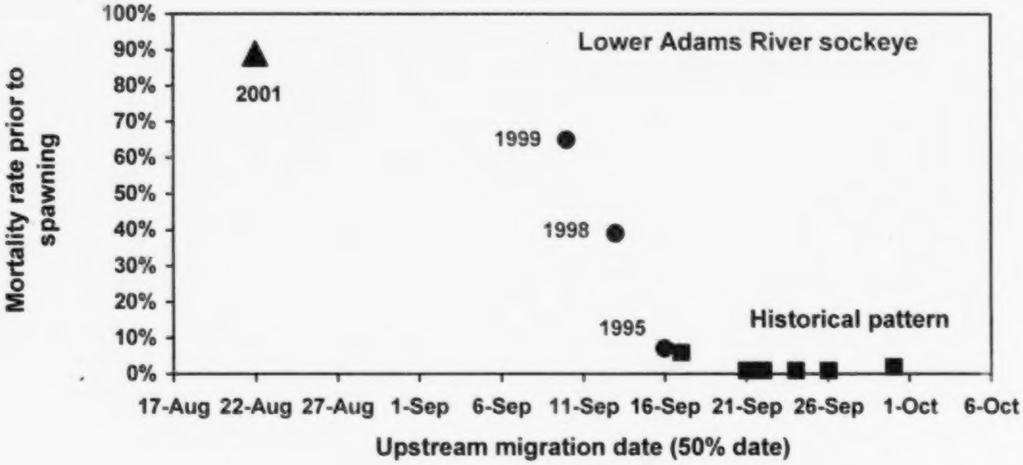


***Figure 2.5**. Pre-spawning mortality rate (percentage of estimated spawning escapement) observed in recent years for the Weaver Creek late-run sockeye salmon.*

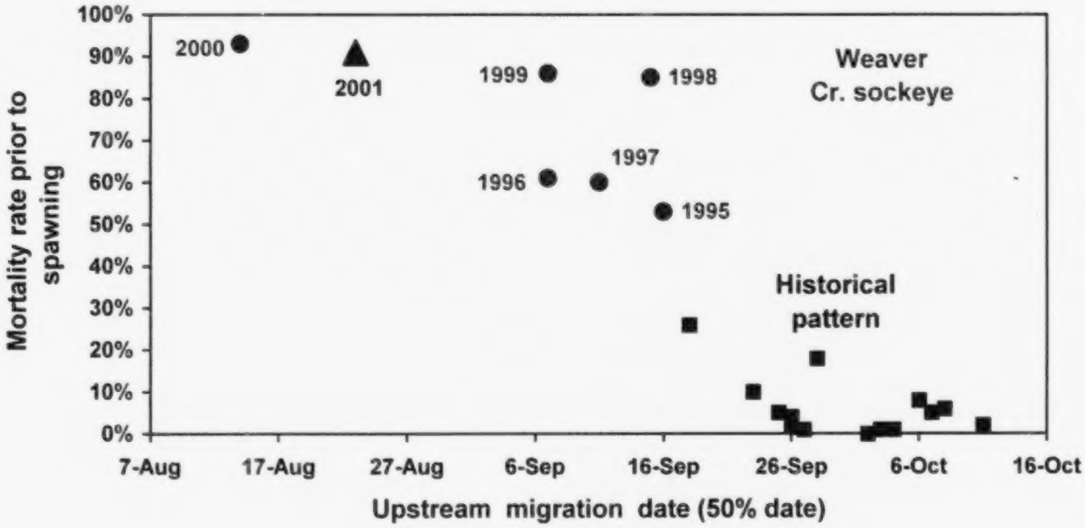
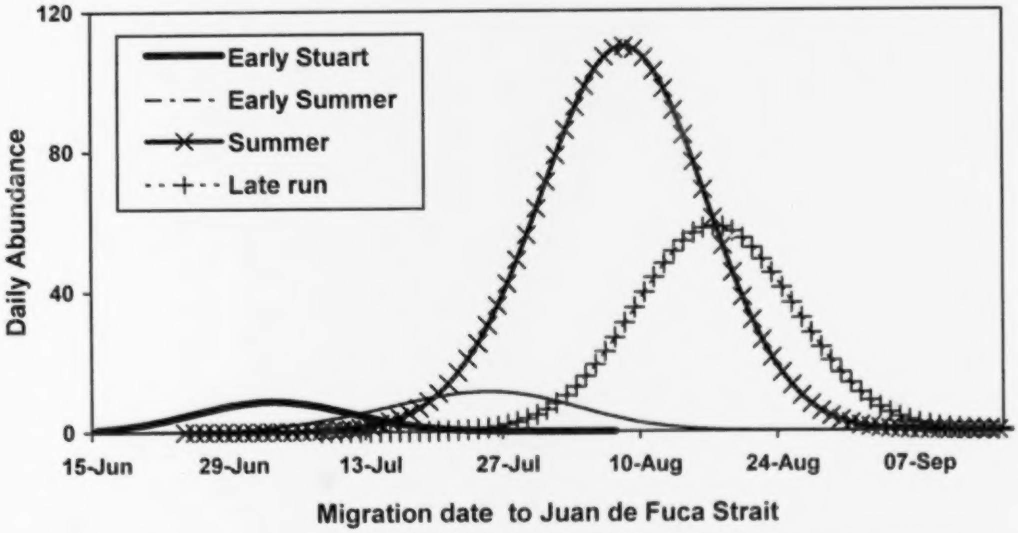


Figure 2.6. Migration timing of Fraser River sockeye stocks estimated as sockeye passing outer Juan de Fuca Strait per day. Note overlap between Summer and Late-run stocks.



Fisheries & Oceans Canada and the Pacific Salmon Commission have begun scientific investigations into this situation, but have devoted only limited resources to the effort. The Council will continue to put forward advice on this serious matter, as it has in the past two annual reports. Council is concerned that this problem has not yet received sufficient attention by federal government officials.

The Council has written to the Minister of Fisheries and Oceans on two occasions in 2002 to reiterate its apprehension about the Late-run Fraser River sockeye and to call for dedicated research efforts and stock management solutions.

As reported in the 2001 Annual Report, there is evidence that salmon survival and production in the ocean environments have improved very recently. Returns of Fraser sockeye stocks in 2002 will provide an important indication of whether or not these stocks will benefit from these changes. They should be monitored closely to evaluate the numbers of sockeye that reach their natal spawning streams. Unfortunately, the stock status message concerning Fraser sockeye is a mix of optimism for improving production from many stocks and severe apprehension about the survival of the late-run sockeye, particularly the severely depressed Cultus Lake sockeye. Care should also be taken when making general statements concerning the status of stocks in any year. For instance, Appendix 1 indicates both positive and negative changes in sockeye production depending on the stock. There is a greater need to review the status of individual sockeye spawning populations and protect the diversity that underlies the production of this important complex of populations.

The Council supports the [illegible] restrictions that were introduced in 2002 to preserve the late-run Fraser River sockeye salmon populations, but strongly urges Fisheries & Oceans Canada to direct additional research funds into identifying the causes of the change in run-timing of these stocks.

In 2002, the limited research program of Fisheries & Oceans Canada, and the subsequent suspension of some recommended Fraser sockeye studies, impair progress towards solving this serious problem. The value of these late-run sockeye populations to Canadians exceeds the limited funds that have so far been directed to address this serious problem.

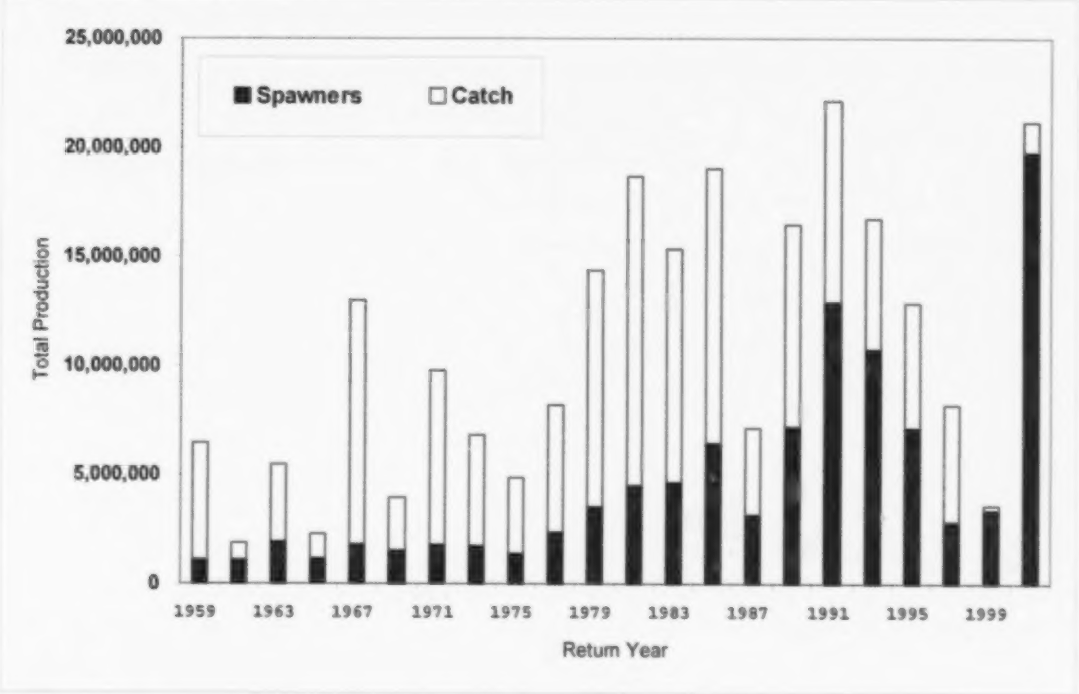
2.2 Fraser River Pink

Pink salmon have the shortest life cycle of any Pacific salmon and they always mature at two-years-old. In the Fraser River, the rigid two-year life cycle results in pink salmon returning only in the odd-years. Spawning can be widely distributed in the lower Fraser and Thompson Rivers, but is concentrated in the Fraser River and tributaries below Hope. There is currently no explanation why pink production in the even-years is absent. Pink salmon spawn in the early autumn and juveniles migrate to the sea soon after emergence from the gravel in the following spring.

The 2001 return of Fraser pink salmon was the second largest recorded return for this stock, and this result was likely the strongest indication of changes in ocean production along the Pacific coast. The rate of adult return per spawner was high (6.2:1) but not exceptional in the time series of data for Fraser pinks. The accuracy of the ratio though is highly dependent on the accuracy of the estimated spawning escapement (20 million pinks), the largest ever recorded (Figure 2.7). This sudden increase in production was unexpected and returns greatly exceeded the pre-season forecast (largest forecast value was 7.4 million, PSARC Proc. Series 2001/030).

The other notable feature of the 2001 return was that few of the pinks were harvested. The estimated harvest rate on the return was only 6.5% and the numbers of spawners in the Fraser River was the largest on record (Figure 2.7) and well distributed in the South Thompson River system and lower Fraser tributaries. Estimates of spawning escapements by tributary are not available because the current estimation methods used to monitor escapements determine only the total return to the Fraser River, not to individual tributaries. It will be important to assess the production resulting from this level of escapement, since previous years of large escapements did not produce higher total production.

***Figure 2.7**. Total production of Fraser River pink salmon, 1959-2001. The estimated numbers of spawners and catch are summed to estimate the total production in numbers of pink salmon. Data provided by the Pacific Salmon Commission.*



The low harvest of pink salmon during 1999 and 2001 resulted from conservation programs meant to limit impacts on interior Fraser River coho salmon and the late-run Fraser River sockeye salmon. Fisheries targeted on Fraser pink salmon would have incidentally caught these coho and sockeye salmon that were to be conserved.

Survival of Fraser pink salmon had been less than two adult returns per spawner since the 1991 spawning year, and this accounted for the decline in pink salmon returns during the past decade. Harvest rates were reduced to compensate for the poor survival, and spawning goals were met, with the exceptions of 1997 and 1999. However, it will be informative to monitor the rate of production from the historical large escapement during 2001 and the distribution of adult pinks returning in 2003.

Despite possible budget cuts in Fisheries & Oceans Canada during 2002 and into future years, the Council urges that an adequate monitoring program for the 2003 spawning escapement be maintained. Furthermore, a co-ordinated sampling program should be designed to examine whether the large 2001 escapement will result in an expanded distribution of the spawning populations within the Fraser basin.

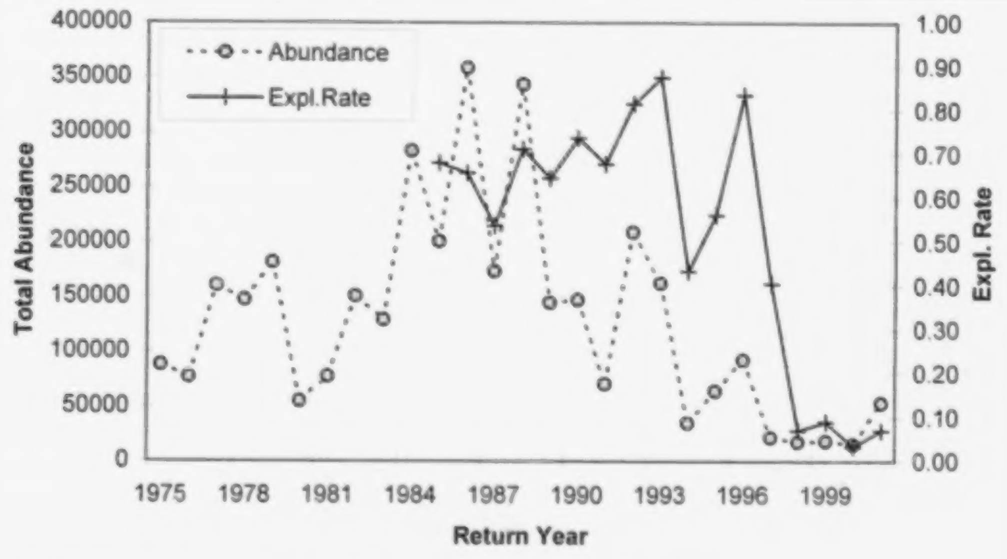
2.3 Fraser River Coho

Two major groups of coho salmon are assessed in the Fraser River. One is a coastal and lower Fraser coho (see Simpson et al. 2001. PSARC Res. Docu. 2001/144), and the other is an interior coho salmon that uses habitats up-river from Hope (see Irvine et al. 2001. PSARC Res. Docu. 2001/083). In recent years, production from both of these groups has been depressed, but it was the seriousness of the Interior coho problems that resulted in the conservation measures that have been taken throughout southern BC fisheries since 1998. It is encouraging to note Irvine et al's conclusion:

> *The extreme fishery management measures undertaken in BC since 1998 to conserve coho appear to have stopped the declining trend for interior Fraser coho populations. ... Fishery exploitations in 2000 were the lowest on record, ~3.4% in total, of which half was in British Columbia. Fishery exploitations the past two years were low enough that spawner numbers generally exceeded brood escapements. Productivity measured in recruits per spawner has improved and populations are now above replacement levels.*

That assessment included data through 2000, and conditions improved again during the 2001 return (Figure 2.8). The estimated total exploitation during 2001 was 7.0% (i.e., 0.07 or 7 out of every 100 adults harvested), and abundance increased 2.5 times the abundance of the 1998 parental spawning year. Returns to interior Fraser, non-Thompson stocks were not included in Figure 2.8 since they have only been recorded since 1998. Returns to non-Thompson coho populations also increased: 8,758 estimated in 1998; 5,924 in 1999; 4,867 in 2000; and 14,533 in 2001.

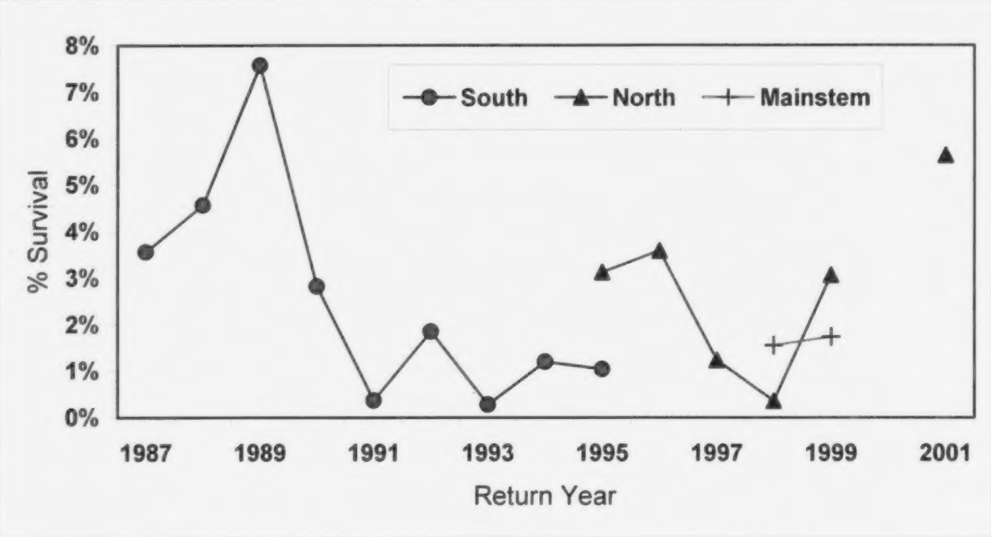
***Figure 2.8**. Estimated total abundance of Thompson River coho salmon and total exploitation rates by year. For methods used in these estimates see Irvine et al. 2001.*



1998-2001 data does not include Non-Thompson coho escapement estimates

Returns in only one year can be compared to one spawning year due to the consistency of age-at-maturity in these coho salmon. The vast majority of adults are three years old and essentially no overlap occurs between spawning lines. This feature also explains why Fisheries & Oceans Canada remains cautious about the status of interior Fraser coho salmon during 2002. While the improvements observed in 2001 are encouraging, the recovery of these coho during 2002 and 2003 are largely independent of the return in 2001. If marine survival accounts for the 2001 returns (Figure 2.9), then returns would also be expected to improve in 2002. Unfortunately, sudden changes in marine conditions are known to occur, so there are no guarantees of improved production at this time. The Council, therefore, supports a precautionary approach to coho management in southern BC during 2002. There are survey results from the Strait of Georgia, however, that indicate very strong production of coho and chinook salmon during 2001 and 2002.

Figure 2.9. *Estimated survival of Interior Fraser coho salmon smolts tagged in the South Thompson, North Thompson, and Mainstem Thompson tributaries since 1984 spawning year (returning as Age-3 mature adults in 1987). Survival is estimated as the number of tagged Age-3 adults accounted for in the catch and spawning escapements divided by the number of tagged juvenile coho migrating to sea.*



COSEWIC Listing of Interior Fraser Coho

The Council notes that Interior Fraser River coho salmon have recently become the first Pacific salmon stock to be listed as endangered by the Committee on the Status of Wildlife in Canada (COSEWIC, website: www.cosewic.gc.ca). An updated version of the report by Irvine et al. 2001 was submitted for consideration by COSEWIC and is the basis for listing the stock. This updated manuscript will be posted on their website. Endangered status indicates that the committee concluded that this stock was at imminent risk of extirpation or extinction. Their concluding remarks attributed the "substantial declines due to changes in freshwater and marine habitats and over-fishing".

Information on the 2001 returns of lower Fraser coho salmon populations also indicates improved marine survival of these stocks (Figure 2.10). The abundance of returns in the lower Fraser River is, however, very difficult to assess. These coho return to disturbed habitats, both urban and agricultural, later in the fall when water conditions are not good for visual assessments. Furthermore, the returns to natural streams are frequently a mix of naturally-produced and hatchery-reared coho salmon. Hatcheries produce significant numbers of coho that mix with natural production. Assessments of lower Fraser coho are largely based on a standardized escapement assessment in the upper Pitt River, monitoring of smolts and adults via a counting weir on the Salmon River, and coded-wire tagging of smolts from these hatcheries.

Uncertainty about the actual number of coho returning is the reason for reliance on the coded-wire tagging programs to assess trends in exploitation rates and marine survival rates of coho salmon in a few indicator stocks. These stocks are assumed to be representative of changes also affecting other local and natural coho populations.

***Figure 2.10**. Estimated marine survival of coded-wire tagged coho salmon smolts released from two lower Fraser River indicator stocks: Chilliwack Hatchery and Salmon River (Langley, BC). Survival is estimated as the number of tagged Age-3 adults accounted for in the catch and spawning escapements divided by the number of tagged juvenile coho migrating to sea.*

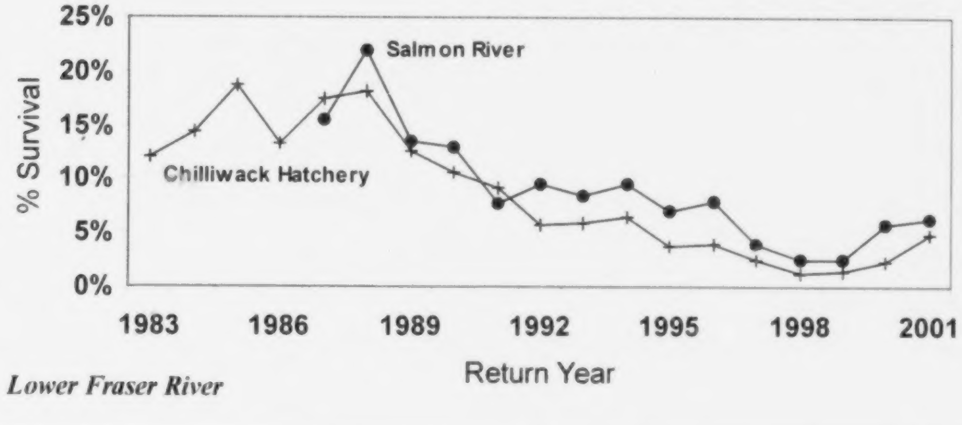


Figure 2.10 shows that even though survival recently improved, the levels of survival are still lower than most previous years. Further, the 2002 forecasts for this stock are for poorer returns compared to the previous year (PSARC Proc. Series 2002/005). Forecasts of 2001 coho returns under-estimated the observed return, but as was argued above for Interior Fraser coho, the return between years for coho may not be related. The Council, therefore, again supports the continuation of a vigilant, precautionary approach to coho management. Restrictions on fisheries for the protection of interior coho will also protect the lower Fraser coho stocks.

The Council acknowledges the efforts of Fisheries & Oceans Canada and the numerous groups that have co-operated in efforts to conserve coho salmon in the Fraser River during the recent period of poor marine survivals. Their joint efforts have reinforced the effects of improved survival in the ocean, resulting in stronger stock status of interior and lower Fraser coho in 2000 and 2001. The Council also supports the continued precautionary approach to coho fisheries in the short term to ensure full recovery of these stocks. Conditions are improving, but they are not yet at sufficient, sustainable levels of production.

2.4 Fraser River Chinook

Chinook production in the Fraser River is the largest in Canada and involves numerous varieties. Chinook populations are aggregated into groups of similar populations based on their run-timing up-river, spawning locations, life history types, and catch distributions in the ocean. Fisheries & Oceans Canada is currently examining the definitions of chinook groups[1] but this Annual Report of the Council refers to only five groups or categories:

1) Upper Fraser Spring-run Chinook that spend one year in freshwater and three years at sea (also includes Birkenhead spring Chinook), Age 1.3 chinook;
2) Mainstem Thompson River spring-run Chinook that spend one year in freshwater and two years at sea, Age 1.2 chinook;
3) Fraser River (mostly mid-mainstem Fraser) summer-run Chinook that typically spend one-year in freshwater and 3 years at sea, Age 1.3 chinook;
4) Thompson River summer-run Chinook that are under-yearling smolts (rear in freshwater for only a few months after emergence) and rear at sea for three years, age 0.3 chinook; and,
5) Fall-run timing Chinook that are largely of Harrison River white Chinook stock[2], are fry emigrants, and return after two or three years at sea.

A detailed description of these stock groups is available in a recent publication of the Chinook Technical Committee of the Pacific Salmon Commission (www.psc.org)[3].

In general, Fraser chinook stocks have benefited from major reductions in ocean fisheries under the Pacific Salmon Treaty (1985 and 1999) and additional reductions to protect interior Fraser coho and west coast of Vancouver Island chinook. Unfortunately, there are no long-term chinook indicator stocks in the upper Fraser River, so exploitation rates on these stocks could not be directly measured. This limitation was addressed recently through resources provided to implement the 1999 Pacific Salmon Treaty agreement but may have been compromised by budget reductions during 2002.

Figures 2.11 and 2.12 summarize a large number of individual populations within the categories defined above, although there are some exceptions to these trends. For example, there are some early spring chinook populations that have continued to decline to small populations. In 2001, however, the returns to these small populations increased.

Exploitation rates on Fraser spring and summer Chinook are believed to be low due to reduced ocean fishing impacts but extent of ocean exploitation is uncertain. Spring Chinook exploitation will largely be within the Fraser River but summer Chinook are more vulnerable to ocean fisheries, followed by fisheries in the Fraser River.

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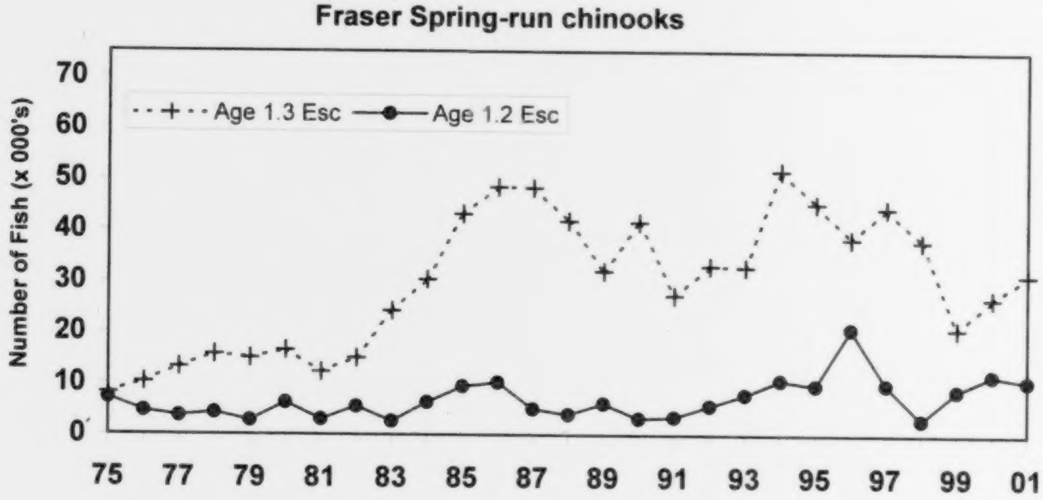
[1] see Pacific Science Advisory Review Committee Proc. Series 2002/005

[2] see Pacific Science Advisory Review Committee Proc. Series 2001/030

[3] see Pacific Salmon Commission Report TCCHINOOK (02)-1. Feb. 8, 2002.

***Figure 2.11**. Time trend in spawning escapements of Fraser River spring run-timing Chinook stocks (categories 1 and 2 above), from 1975 to 2001 returns.*



Fall-run Fraser chinook salmon are assessed on the basis of the spawning escapements to the Harrison River (largely a natural population, but includes the Chehalis Hatchery) and the returns of hatchery and natural chinook to the Chilliwack River. Harrison River white chinook stock was transplanted to the Chilliwack Hatchery in 1981. Until recently, the vast majority of the Fraser fall run returned to the Harrison River, but returns to the Chilliwack River have equalled the Harrison in some recent years (Figure 2.13). The production trend for Fraser fall-run chinook does not show the increasing trends of the spring and summer chinook stocks. The perception of an increase is due to the expanding production from the Chilliwack fall chinook population.

***Figure 2.12**. Time trend in spawning escapements of Fraser River summer run-timing Chinook stocks (categories 3 and 4 above), from 1975 to 2001 returns.*

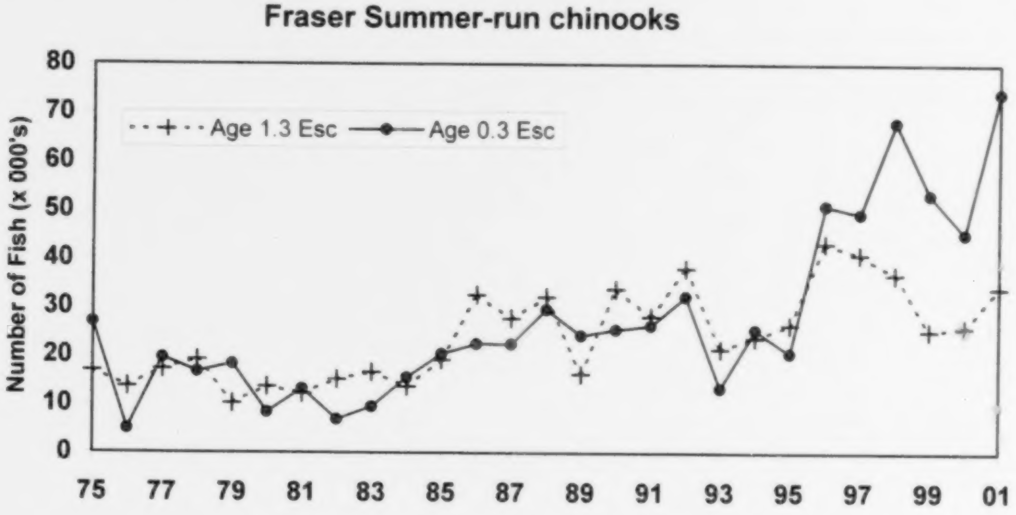
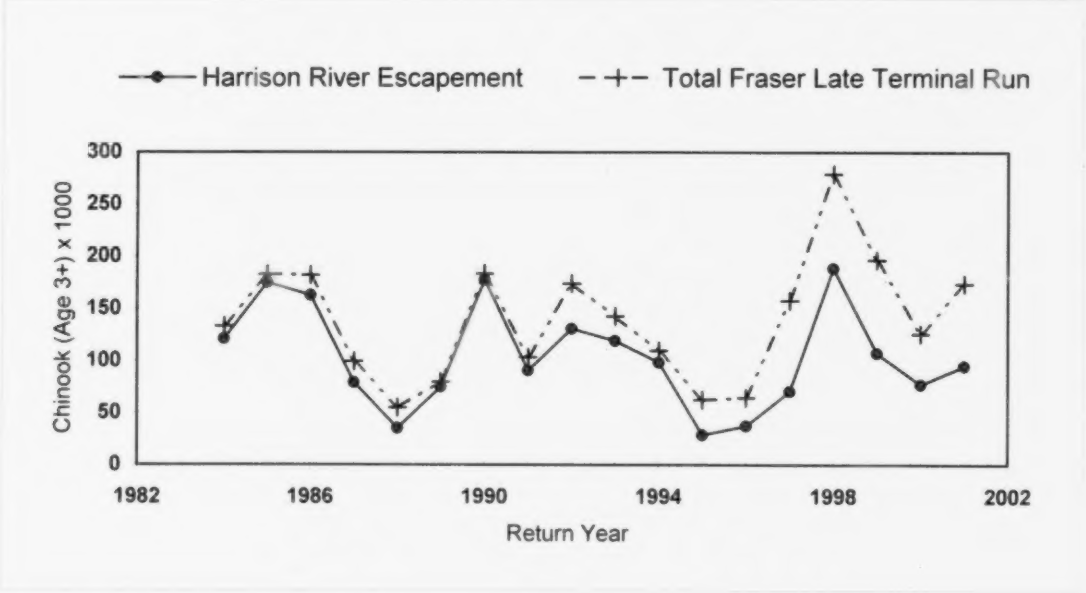


***Figure 2.13**. Total return to the Fraser River of Fall-run white Chinook salmon returning to the Harrison and Chilliwack rivers. Harrison escapement includes all spawners, and the total run includes Harrison escapement, Chilliwack total escapement, and all terminal catches. Harvest rates in fisheries within the Fraser River (terminal catches) have averaged less than 5% during these years.*



The lack of an apparent trend is due to the large variation in brood survivals for the Harrison stock during this period. Survivals have varied by over one-hundred-fold in this time period and were very poor for the 1991 through 1993 spawning years (progeny produced per parent was ~0.5:1). A detailed assessment of the Harrison River and Chilliwack Hatchery production was recently completed, and it established the first biologically-based escapement goal for a BC chinook stock (see PSARC Proc. Series 2001/030)[4]. While these Fraser chinook are not increasing in production, their stock size indicates that they are not at risk. This stock is very important to monitor, however, as it is a principal stock contributing to fisheries in southern BC and Washington State.

It has been suggested that the returns in Figure 2.13 may not represent the true potential from the Harrison white chinook stock. The escapements to the Harrison River have averaged 104,000 chinook during this period but could have been much greater during earlier periods. The use of a current but short time series in a resource assessment is referred to as the "shifting baseline" phenomenon. The problem is that past levels of production would have been much greater, and there is a tendency to under-value production potential by not including a longer-term perspective in the assessment. For Fraser River fall-run white chinook, however, it is difficult to compare since past escapement data was based on visual counts and the portion of the return to river taken in commercial nets is unknown (Figure 2.14). But ocean exploitation rates during the period in Figure 2.14 would certainly have been over 50%. Conservative estimates of past total production from one spawning year of Harrison River fall chinook could therefore have been 200,000 to 300,000 fish!

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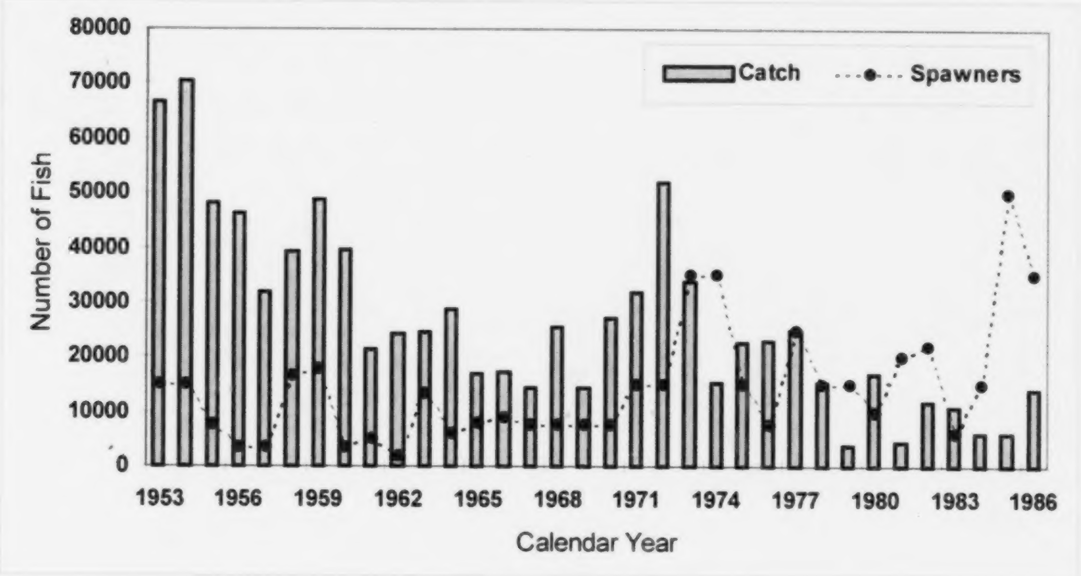
[4] www.dfo-mpo.gc.ca/csas/csas/Proceedings/2001/Pro2001_030e.pdf

***Figure 2.14**. Historical commercial gillnet catches of white chinook (August to year end) in the Fraser River (bars) and the visual estimate of spawning escapements (circles and dashed line) recorded in the Departmental records.*



However, applying reasonable expansions for harvest rates in these net fisheries (20%-30%) or expansion of the visual escapement estimates (4 to 8 times, Starr and Schubert 1990) would suggest that the early years shown in Figure 2.14 would have had terminal runs substantially larger than 104,000. Over the 1953-1986 period, though, only about half of the years would likely exceed the recent average of 104,000. These estimates do not account for the rate that white chinook were taken in fisheries outside the Fraser River. This stock is harvested in troll and sport fisheries in the Strait of Georgia and on the West Coast of Vancouver Island, as well as in the US and Canadian commercial net fisheries. These harvests in ocean fisheries would have been reduced after the 1985 Pacific Salmon Treaty.

It is likely that production of fall white chinook was greater in past years, but the uncertainty associated with the current years (Figures 2.13) was acknowledged in the Fisheries & Oceans Canada assessments. While an escapement goal was recommended (management range 60,500 to 98,500 spawners in the Harrison River), there was also a recommendation to allow larger escapements when possible to test the production potential of this important chinook stock.

The Council notes that the absence of any long-term chinook indicator stocks in the upper Fraser River is a serious limitation to assessment and management of this diverse resource. The Council is also aware that the Fisheries & Oceans Canada started to address this limitation through funds to implement the 1999 Pacific Salmon Treaty. Given the impending departmental budget cuts, the Council strongly recommends the establishment and maintenance of a core assessment framework for upper Fraser River chinook salmon, including tagged stocks to assess marine survivals and changes in fishery exploitation rates.

Regarding the Harrison natural population the Council supports an examination of the production resulting from escapements larger than the escapement range whenever possible. Furthermore, production of Harrison River white chinook is largely determined by environmental conditions in freshwater and the ocean. Consequently, in order to assess changes in escapements it will be essential to maintain programs to monitor survival rates and changes in fishery exploitation rates.

2.5 Fraser River Chum

Chum salmon are largely distributed in the Fraser River below Hope, and there are 121 streams where chum spawning has been reported. The vast majority of Fraser chum production, however, is limited to about 10 streams, including the Harrison, Chehalis, Chilliwack, and Stave rivers. These rivers each involve large natural spawning populations and major hatchery programs. Spawning is also known to occur in the mainstem Fraser River, principally between Chilliwack and Hope, but there are no reliable estimates of those spawners due to the turbidity of the river.

Escapement records for Fraser chum salmon indicate a significant increase in the numbers of spawners during the past two decades. There are at least three major contributing factors to this: major hatchery programs in the Fraser River since the early 1980s; the fishery management plan[5] intended to reduce the portion of the chum return that is harvested; and quantitative escapement monitoring programs in the major spawning systems. Most escapement monitoring programs for chum salmon have been based on visual observations that under-estimate the actual number of fish spawning. As in other areas of the coast, these visual counts are treated as indicators of trends in escapements, but not as accurate estimates of the number of spawners. Consequently, when quantitative programs are implemented, they are not consistent with past observations and will immediately increase the reported escapements, even if the numbers actually spawning did not change. Visual observations are relative indices as opposed to absolute values.

Chum salmon migrate to the sea immediately after emergence from the gravel and are generally too small to tag. Consequently, allocation of catch to chum populations has usually been conducted by reconstructing the catch in fisheries. The method simply works backward from the estimated spawning population size, assumes a set of adult migration patterns and rates, and then estimates the catch of each component stock in a fishery (defined by a location and time period). The significance of these methods is that Fraser River chum must be assessed within a larger geographic grouping of chum salmon stocks including Johnstone Strait, the Strait of Georgia, and Puget Sound chum salmon.

More recently stock identification methods using biological markers (e.g., protein or DNA markers) have also been used to verify catch estimates. Chum reared in hatcheries could also be marked using thermal marking of otolith (small bones in the ear) but this tool is not currently used for stock identification.

The Canadian chum populations in this aggregate make up the "Inner South Coast" chums that are managed in aggregate due to their similarity in migration paths and timing. The major fisheries on these stocks have historically occurred on large mixtures of these stocks in Johnstone Strait and outside of the Fraser River, including US waters south of the Fraser River. The exception to the tagging of chum salmon are hatchery-produced chum fry that can be reared until they are large enough to be identified by marking (coded-wire tags or fin clips). Fisheries are then sampled for these marks and estimates made of the hatchery contributions to catch. Consequently, when chum salmon are assessed in southern BC, the population definitions are limited to Fraser and non-Fraser chums, and natural versus hatchery production (i.e., only four major stock groupings). The last major assessment of these stocks was prepared by Ryall et al. (1999) and is a very informative overall assessment of the Inner South Coast chum[6]. More general descriptions of Fraser River chum salmon biology are also available in Beacham and Starr (1982), a Fraser River Action Plan report (Anon. 1996), and a recent Stock Status report[7].

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[5] Johnstone Strait Clockwork Management Strategy implemented in 1983 (see Hilborn and Luedke, 1987) and the Fraser River Clockwork plan implemented in 1987 (see Gould et al. 1991).

For further discussion of chum salmon in southern BC including the Fraser River, see the section on chum salmon in the Strait of Georgia section of this report. Note that the data from the Ryall et al. report has not been updated through 2001 since escapement records for 2001 could not be provided for this report. An assessment of the data for 1998 and 2000 did not change the results presented in the Ryall et al. document.

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[6] See Ryall et al. 1999, www.dfo-mpo.gc.ca/sci/Pacific Science Advisory Review Committee/ResDocs/diadrom_99.htm

[7] Inner South Coast Chum Salmon. 1999. see: www.dfo-mpo.gc.ca/sci/Pacific Science Advisory Review Committee/SSRs/diadromous_ssrs.htm

3. Okanagan River Sockeye

While the Okanagan is not renowned as a salmon-bearing region, sockeye continue to survive in the lower Okanagan River and Osoyoos Lake. These sockeye have the distinction of reportedly being the last of six anadromous salmon species that historically returned to the Canadian Okanagan River. Unfortunately, the Okanagan River also has the distinction of being declared BC's most endangered river (Outdoor Recreation Council of B.C., March, 2002) and amongst Canada's four most endangered ecosystems (Hon. David Anderson, July 31, 2002).

Okanagan sockeye must deal with the Columbia River hydro-system and pass nine dams, both as emigrating juveniles and as returning adults. One might be surprised then that sockeye have survived in this transboundary river and in the past two years have returned in much larger numbers. The conservation and restoration of sockeye in this basin is a huge challenge, but one that has been accepted by many organizations in the Okanagan River region. The Chiefs of the Okanagan Nation have recently declared their intention to rebuild the Okanagan River and its salmon, and a recent scientific[8] meeting brought proponents and technical experts together to consider how to develop an ecosystem-based approach to restoration of fish and associated habitats in the Okanagan Basin.

These sockeye spawn in the Okanagan River downstream of McIntyre Dam (downstream of Vaseux Lake) and rear in the north basin of Osoyoos Lake. Development, human population growth, and flood control features have extensively degraded their habitat (Map 3). In the lower Okanagan River over 90% of the natural stream channel has been lost and most of the stream-side riparian habitat. The most recent comprehensive stock assessment of Okanagan sockeye was prepared by Hyatt and Rankin (1999). That assessment recommended a minimum spawning population size for Okanagan sockeye (58,730 Wells Dam count "units" or 29,365 peak visual counts on the spawning ground), identified that habitat limitations did not "appear to set the principal limits on Okanagan sockeye population size at current stock sizes", and identified a number of information needs to improve the assessment of this stock.

The difference between the Wells Dam counts and spawning ground counts in the Okanagan River identifies a major question in the assessment and management of this stock. Wells Dam is the last up-stream Columbia River location that adults must pass during their migration and all sockeye counted at that dam are assumed to be destined for the Okanagan River. However, the dam is approximately 180 kilometres from the Okanagan River and the lower Okanagan River in the United States is a low velocity and warm water system. It would be expected in this arid climate region that these sockeye could be at risk of significant pre-spawning mortality. The spawning ground counts, though, are largely based on visual counts that are known to under-estimate the true total spawning population size (a point fully examined by Hyatt and Rankin 1999). Consequently, although we have counts of returns at Wells Dam (target accuracy is ±5%), the difference between dam and spawning ground counts likely results from an unknown mix of pre-spawning mortality and incomplete enumeration. If the goal is to restore fisheries in Canadian sections of the Okanagan, then a significant issue will be determining the losses between Wells Dam and the spawning grounds to avoid over-harvest of the adults.

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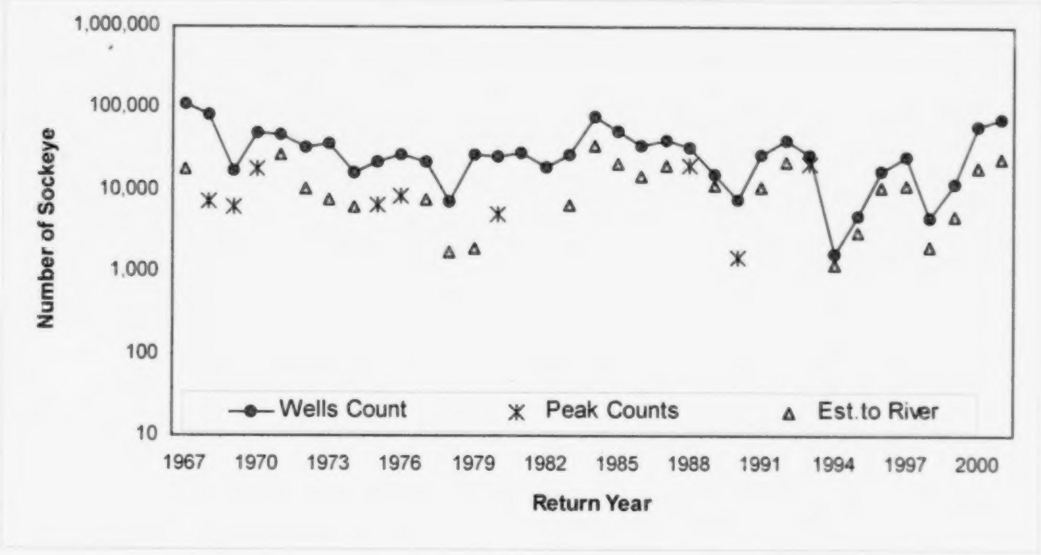
[8] Toward Ecosystem-Based Management: Breaking Down the Barriers in the Columbia River Basin and Beyond. Spokane, WA April 27-May 1, 2002. Sponsored by the American Fisheries Society and the Sustainable Fisheries Foundation.

Past sockeye returns to the Okanagan River have been highly variable (Figure 3.1) and depended on natural variation in productivity (juveniles produced, dam passage, and ocean conditions) and US fisheries in the lower Columbia River. Historically, these fisheries imposed high harvest rates (70-80%) but in recent years have been greatly reduced for conservation of several species in the Columbia River basin. In 2001, the estimated catch of Okanagan sockeye in the United States was about 5,000 fish for a terminal harvest rate of only 6% (count at Wells Dam was 74,490 sockeye, Fryer and Kelsey 2002).

***Figure 3.1**. Returns of Okanagan sockeye salmon, 1967 through 2001 based on fishway counts at Wells Dam (Columbia River, line), peak visual counts of the spawning sockeye in the Okanagan River (Hyatt and Rankin 1999, asterisks) or the estimated return to river based on standardized peak counts of live and dead sockeye salmon (K. Hyatt, pers. comm., triangles). Counts are expressed on a scale to show the wide range of values, but the number of sockeye can be read directly from the graph. For example, the maximum number of sockeye in the Okanagan River was about 35,000 in 1984, but counts at Wells Dam exceed 100,000 sockeye in 1967.*



This figure shows that as many as 75,000 to 100,000 Okanagan sockeye have been counted past Wells Dam, since its completion in 1967, but the scale does not easily demonstrate the problem of accounting for sockeye that passed Wells Dam on the spawning grounds. For the 24 years that comparisons can be made between Wells Dam counts and quantitative estimates of spawning ground numbers, sockeye on the Okanagan River spawning grounds account for only 31% (on average, range 4% to 64%) of the sockeye counted at Wells Dam! What portion of these "missing" fish are due to pre-spawning mortality versus problems with the spawner enumeration programs?

Production of these sockeye is dependent on their successful spawning in the river and the capacity for rearing in Osoyoos Lake. Lake-rearing capacity is not currently considered a limiting factor since sockeye leaving the lake are amongst the largest known. However, Rankin[9] has reported that lake rearing is limited by two factors: the "17 degree" rule (sockeye fry will utilize water only up to 17 degrees) and "4 mg" rule (sockeye will not use water with less than 4 milligrams oxygen). Consequently,

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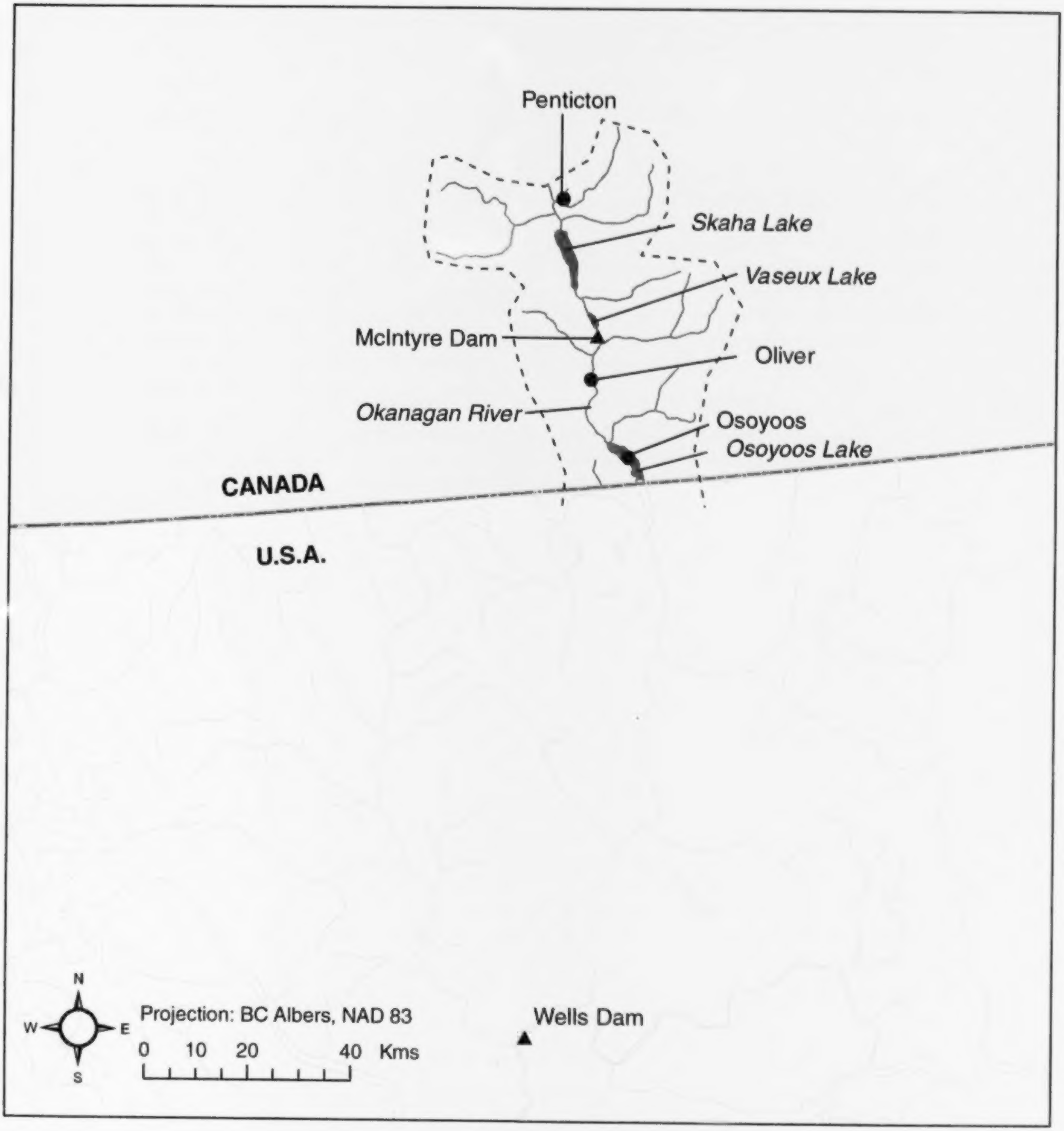
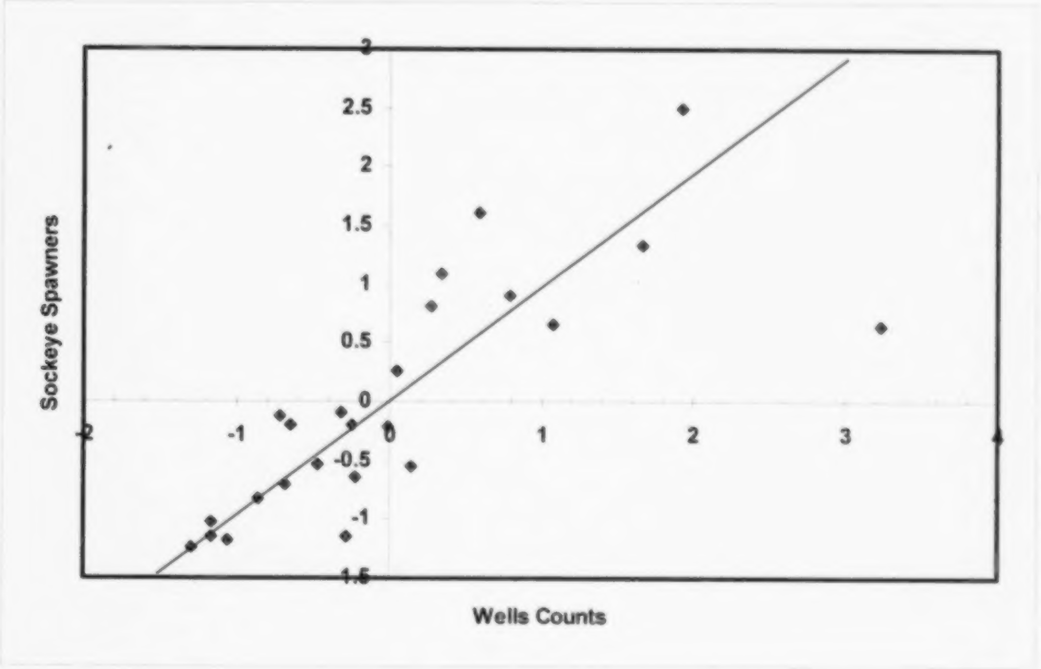
[9] Rankin, P. 2002. pers. comm. Presentation at conference referenced in previous footnote.

Map 3: Okanogan Region



production is limited to the north basin of Osoyoos Lake. If the number of sockeye increases in the future, then rearing capacity may become limiting, but the immediate need is to determine the true spawning population and fry survival to the lake. Concerning the latter, a question that can be asked is whether or not the visual surveys of spawning sockeye are representative of the actual return of sockeye. If so, the peak counts should be proportional to the total return (Wells Dam count). To examine this, Wells Dam counts and the estimated number of sockeye in the Okanagan River[10] were each standardized (standardized normal deviates) and plotted against each other (Figure 3.2).

***Figure 3.2**. Standardized counts of sockeye at Wells Dam and numbers of spawners in the Okanagan River (n = 24 years). The diagonal line represents a 1:1 line of correspondence between the counts.*



Given the uncertainty about mortality between the dam counts and spawning grounds, and the methods used to estimate spawning ground counts, the relationship is quite linear but with substantial variability. In other words, the data points are scattered randomly about the diagonal line. Overall then, the spawning ground counts are representative of the total sockeye returns, but the variability will be too large for more quantitative assessments. An accurate estimate of the total return will be needed to determine if pre-spawning mortality is important and to study freshwater production in the sockeye life cycle. An immediate need for these restoration efforts will be to improve the consistency and accuracy of annual spawning ground surveys.

Another major issue in a restoration effort of the magnitude required in the Okanagan River is the support from the numerous stakeholders involved. The Council was represented at the Spokane conference mentioned earlier. Participants included government agencies (federal, provincial, First Nations, and United States), academics and NGOs, and members of the public. One message that seemed particularly appropriate though was that with complex resource issues, the organization and process challenges are often more important to initial progress than the scientific/technical debates. The participants who provided that perspective also suggested addressing two important initial questions:

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[10] Data provided by Dr. K. Hyatt and based on 24 years with standardized peak live plus dead count of sockeye, and a regression estimate of the total return to river.

1) Is there a common vision? Lots of people may apparently be involved but are their activities and objectives compatible?
2) Have all potentially affected peoples been included? (In this case, have all the partnerships linked to salmon been considered and involved?)

The comments of one community speaker clearly indicated that progress on the technical material is ahead of the public discussion and consultations, but there is a strong community desire to be involved and support the work in ways that include:

1) sharing information effectively for the development of common goals and visions;
2) developing a "key" focal point project for demonstration purposes; and,
3) participating as equal partners with government and scientific partners.

The restoration of sockeye salmon first, and then other fish species, in the Okanagan River basin is a challenge in management of multiple resource uses and competing interests. The biological opportunity for sockeye exists and the co-operation between scientists and management agencies is apparent. However, given the scope of issues and the multiple levels of governance involved across provincial state, and international borders, there is not yet a central or focused lead organization, or commitment of resources. The coordination of people and funds from numerous and fragmented sources is necessary, as is the commitment to long-term involvement, participation and support. The Council will continue to work with individuals and groups to help build an organizational framework, demonstration projects, and consensus on priority activities for sockeye salmon rebuilding and conservation. The opportunity to restore Okanagan sockeye production and one of Canada's most disturbed ecosystems seems apparent biologically but the tasks are inherently long-term and will be costly.

The Council notes that there is an obvious and immediate need for dedicated resources for annual monitoring and research into the factors limiting the production of sockeye salmon at each life history stage, both in the Okanagan basin and their broader ecosystem outside the basin. The results of this research should direct future steps to restoration, assist in the development of realistic and common goals for restoration, and assist in the evaluation of trade-offs between the multiple user groups.

It should be observed that provision of dedicated Canadian resources could also facilitate access to funds from the US hydropower industry that is required to help mitigate current environmental problems as a result of their past development practices. A joint US and Canadian restoration program could greatly facilitate the conduct of this research and restoration efforts.

The restoration of Okanagan sockeye salmon and their ecosystems will likely involve as many social/cultural complications as it will biological and environmental ones. While these topics may be beyond the Council's mandate, it should be expected that stakeholders and local organizations would identify a lead organization as the focus for this initiative and a communication process to ensure common understanding of goals, potential benefits and impacts on all users and communities. Restoration of these natural resources will be a true test of the resolve of both countries and their ability to co-operate, especially amongst several governmental levels and non-governmental institutions.

4. Strait of Georgia and Johnstone Strait Salmon

For the purposes of this chapter, the Strait of Georgia region is defined as the east coast of Vancouver Island and the mainland surrounding the Strait of Georgia, Johnston Strait, and Juan de Fuca Strait, but excluding the Fraser River basin (Map 4). The area includes a large number of small to medium sized rivers, plus the larger rivers of the mainland inlets. Development has been extensive along the east coast of Vancouver Island and includes several large enhancement programs.

The region is the population centre of the province. Recent census data indicates that two-thirds of the provincial population resides in the eight Regional Districts adjacent to the Strait of Georgia, Juan de Fuca Strait, and Johnstone Strait. Further, the population in these Regional Districts is projected to expand by a further 40% by 2026. Population projections indicate steady growth, doubling the human population between 1986 and 2026, with all the associated impacts on water use, habitat, and fishing pressures.

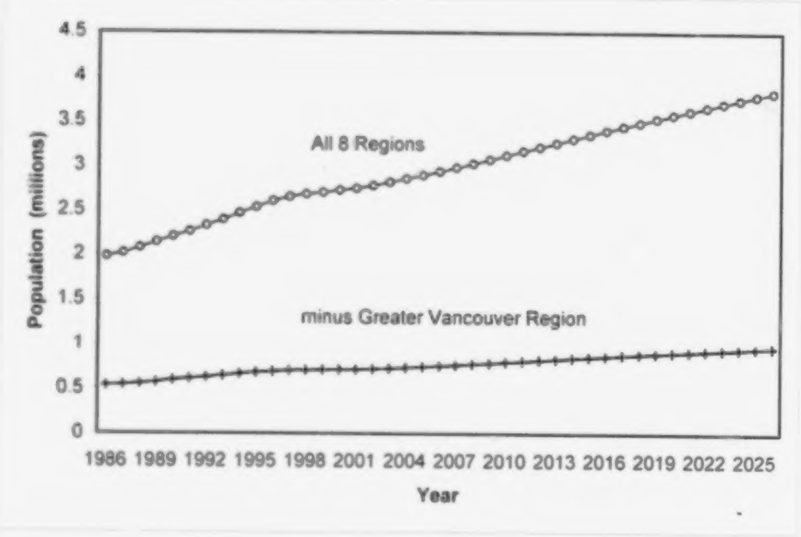


***Figure 4.1**. Cumulative human population growth projection for eight Regional Districts adjacent to the Strait of Georgia region as defined in this paper (Comox-Strathcona, Capital Region, Cowichan Valley, Greater Vancouver, Mount Waddington, Nanaimo, Powell River, Sunshine Coast). Projection determined by the BC Ministry of Management Services (see BC Stats Population Projections, June 2001)*

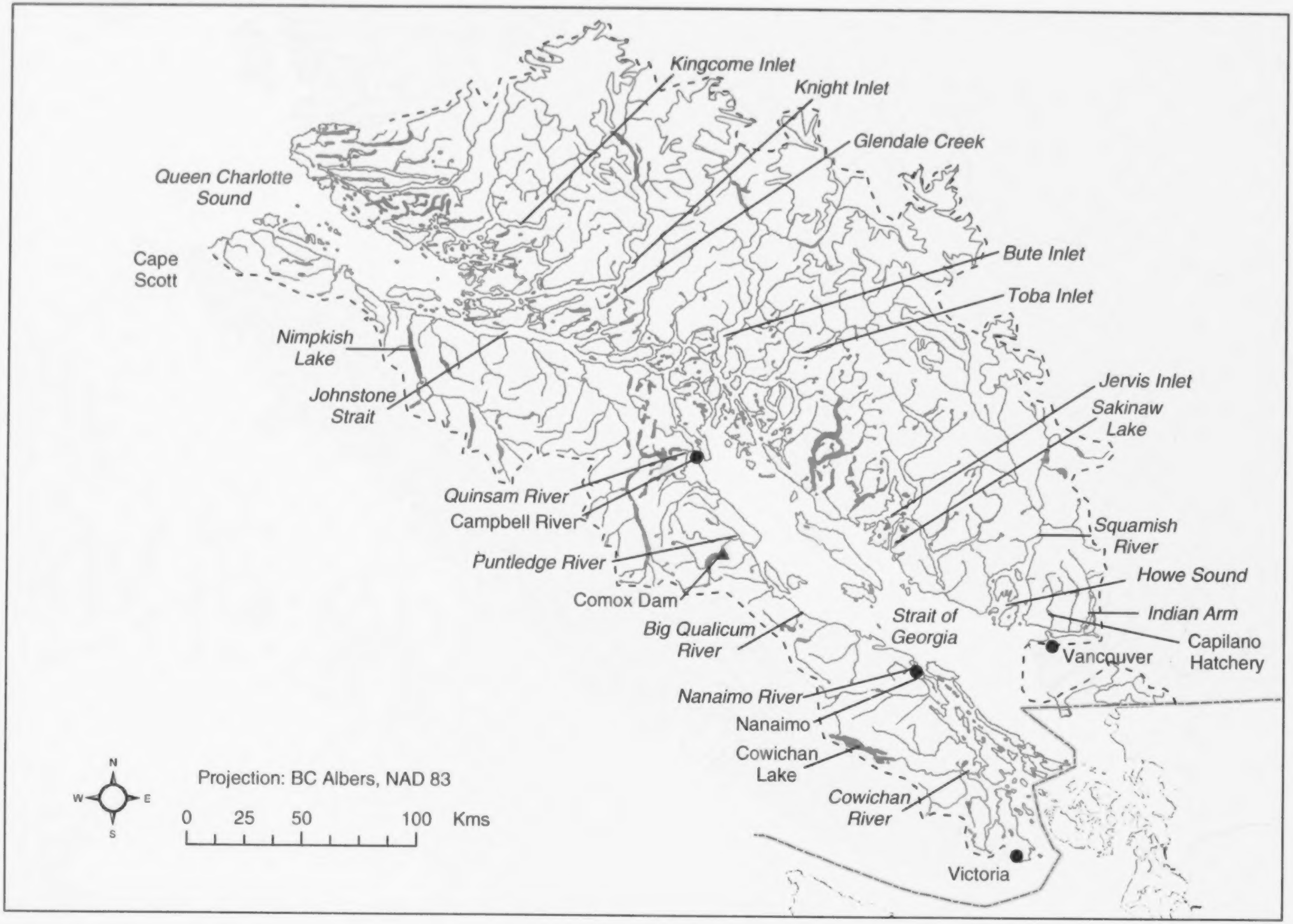
The negative effects of past population growth and development are already evident on salmon and steelhead resources in this region, and these were chronicled in recent Council background papers on habitat.

4.1 Strait of Georgia Sockeye

Sockeye salmon in the region are known to inhabit several small coastal lakes, the large rivers in the mainland inlets, and the Nimpkish River system, but they are not present in some of the larger lake systems along the east coast of Vancouver Island.
Where sockeye have been present, their status is highly variable and in many cases uncertain due to a lack of survey effort. Sockeye abundance has been significantly reduced through habitat impacts and mixed-stock fisheries for Fraser sockeye and pink salmon.

Along the east coast of Vancouver Island, sockeye have a limited distribution. Few sockeye are known to have used the Cowichan Lake system but kokanee exist in Cowichan Lake (Neave 1949). Sockeye are infrequently recorded in the Nanaimo River system (four small lakes) and those are considered likely to be strays from other

Map 4: Strait of Georgia Region



systems. Sockeye may have utilized Comox Lake and Puntledge River, but documentation before construction of the Comox Dam in 1913 did not identify species.

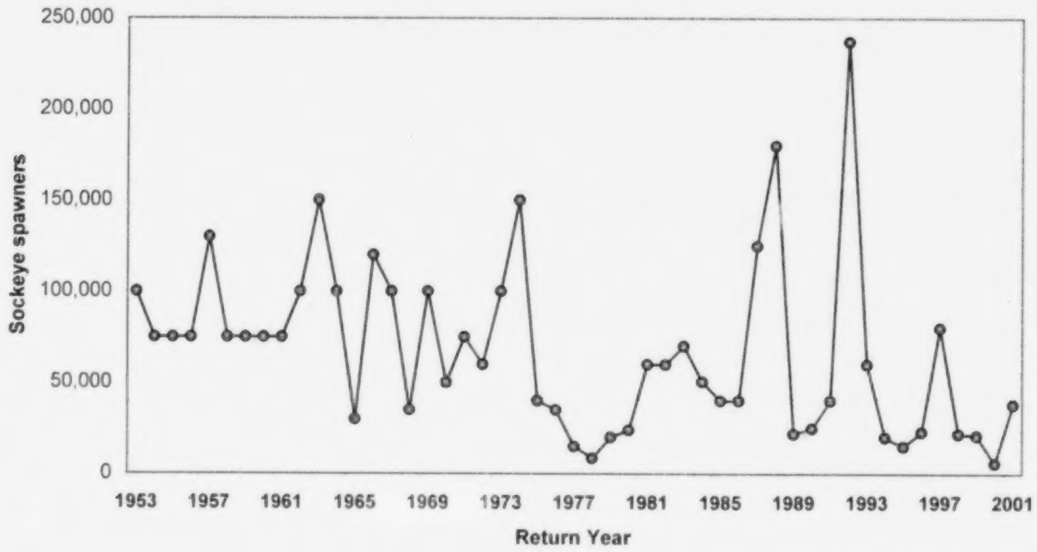
> *Only the lower 13 km of the Puntledge are presently accessible to spawning salmonids, as upstream migration is limited by the Comox Dam.The upper Puntledge River, the Cruikshank River, all the tributaries of the rivers and Comox Lake once supported large salmonid populations.* (page 80, Morris et al. 1979)

There is also documentation of sockeye introductions into Comox Lake, but with very little success. Remnant numbers of sockeye are still observed in this system although their origins are again unknown. Similarly, sockeye are recorded in the Campbell River system, but sockeye are not endemic to the upper lakes due to Elk Falls located only five kilometres up the Campbell River (Bell and Thompson 1977).

The Nimpkish watershed is the largest non-Fraser River producer of sockeye salmon in the Strait of Georgia region. Most investigators agree that historically the population size of these sockeye was much larger than the recorded spawning escapements (Figure 4.2). The escapements appear to alternate between fixed population levels, but this is simply an artifact of the past means of recording spawning stock sizes (i.e., letter categories assigned for ranges of escapements). The categories were heavily weighted to the lower escapements with nine of ten allowable categories for escapements less than 100,000 salmon, but only one for greater than this level. Past escapement surveys in the basin were discussed by Weinstein (1991).

Sockeye returns to the Nimpkish are also composed of two run-timing groups: an early run (mid-May to mid-June) to Vernon Lake in the upper Nimpkish River, and a mid-summer run (mid-June to August) returning to the main spawning grounds of Woss Lake and River and upper Nimpkish Lake. In the mid-1970s, the spawning escapement of Nimpkish sockeye was extremely depressed, a situation that led to a review of how sockeye fisheries in Johnstone Strait were conducted and impacted Nimpkish sockeye. Significant changes in the conduct of this fishery (time, area, and day open to fishing) are largely credited with the preservation of this stock, but enhancement programs were also initiated. A small sockeye hatchery was constructed and the Lake Enrichment Program of Salmonid Enhancement Program fertilized Nimpkish Lake during the mid-1980s.

***Figure 4.2**. Spawning escapements of sockeye salmon recorded for the total Nimpkish River valley (data from spawning escapement records, 1953-2001). Returns to the two run-timing components are not distinguished in this figure.*



Recently, the escapement to this system has been much less than capacity of the rivers and lakes, and the poorest escapement ever recorded occurred in 2000. Fortunately the 2001 return improved substantially. Other sockeye systems in the northeastern island include returns to Nahwitti Lake and the Shushartie River (although returns to the Shushartie have been recorded infrequently). Sockeye returning to the Nahwitti River have an early run-timing and seem to have faired better than other small lake systems. Returns were historically a few thousand per year, but recent levels are reduced to approximately one thousand sockeye.

Along the mainland side of the Strait region, sockeye use the large river systems in lower Queen Charlotte Sound and Johnston Strait (Kakweiken River - Thompson Sound, Klinaklini River & Devereux Creek, and Ahnuhati River (Knight Inlet), and Kingcome River - Kingcome Inlet). The remoteness and glacial nature of these systems makes assessment in them difficult. Their status is uncertain, although increased returns have been recorded recently in some of them.

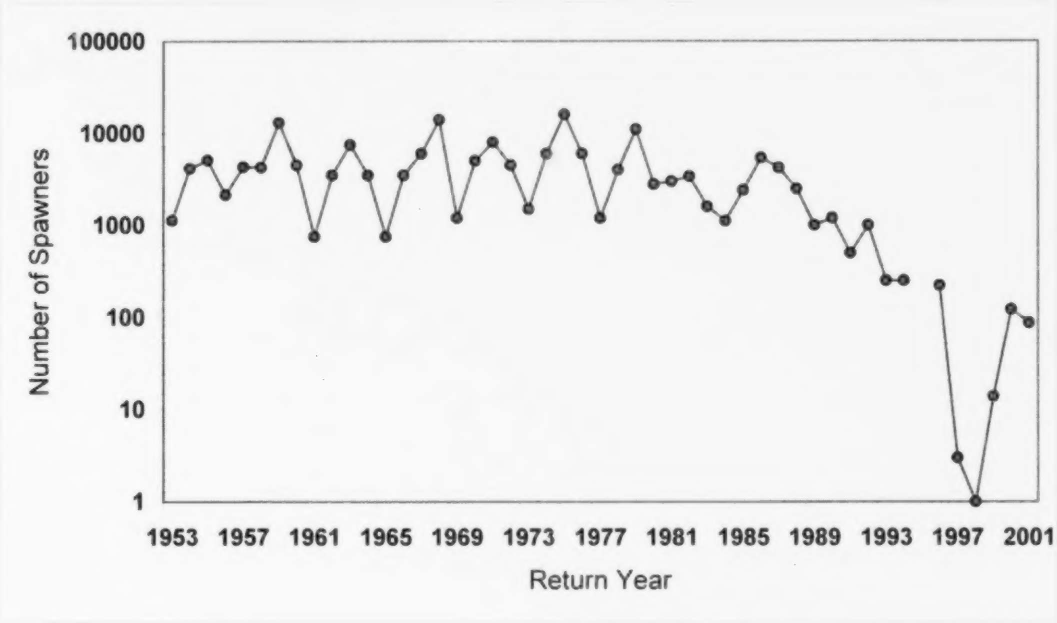
On the islands and along the mainland shore there are also a number of smaller coastal lakes that supported sockeye salmon (Table 4.1). The table presents detailed information about these small sockeye populations but the Council deemed this information to be important. Under the federal government's proposed Wild Salmon Policy each of these populations may become a conservation unit for management purposes. Individual sockeye salmon populations are frequently genetically different from their neighbouring populations and have different population dynamics determined by the spawning habitats and rearing lake conditions. If conservation of diversity becomes an objective under the draft Policy, then conservation of each of these sockeye populations could be required.

***Table 4.1**. Identification of sockeye salmon populations in small lakes along the islands and mainland of the Strait of Georgia region. Watershed codes from BC Provincial Fisheries Inventory system*

Spawning Stream and Lake	Location & (Watershed code)	Assessment and popn. size	Frequency of Assessments
Fulmore River and lake	Port Neville area (900-521100)	Returns of 2,000 to 4,000 until 1980s but now reduced to approx. 1,000.	Monitored every year 1953-1985 but infrequently since, 2001 return recorded as Unknown.
Glendale Creek and lake	Knight Inlet (900-569800-08600)	Original estimates recorded as 750-3,500 but reduced presently. Average return in past decade only 107 fish.	Very little information recorded since 1962. Past decade average based on only 3 entries. 2001 return recorded as Unknown.
McKenzie (Sound) River and Lake	Kingcome Inlet (900-712900)	Population size recorded as 1,000 to 15,000 until late 1970's. Since then average returns only a few hundred per year. Improved to over 1,000 in 2000.	Escapement was recorded every year until 1980 but frequency reduced by one half since. No data yet recorded for 2001.
Heydon Lake & Creek	Loughborough Inlet (900-477600)	Up to a few thousand returns until mid-80's. Now very depressed with no data for 2001	Escapement was recorded every year until 1980s but frequency reduced by one half since. Counting weir recently installed.
Phillips Lake	Phillips Arm (900-447800)	A few thousand to now several thousand annual returns. 2001 return recorded as 1,600.	One of two coastal lake system to have escapement recorded in each year since 1953.
Village Bay Lake and Clear Creek	Quadra Island (905-291000-76900)	No sockeye recorded until 1970 and increased through 1980s. Poorer returns recorded recently (except for 1997).	Limited monitoring during the 1990s and no data provided for 2001.
Ruby Creek and Sakinaw Lake	Lower Jervis Inlet (900-147300)	See figure 4.3	Data recorded for every year since 1953.
Tzoonie River and Lake	mid-Jervis Inlet (900-19500)	Previous to 1970, values between 400 & 7,500 annually. No sockeye recorded after 1970.	Recorded as none observed or Unknown since 1970. Records provided for every year before 1970.

A first step in examining these populations was recently presented to the May 2002 PSARC meeting regarding the status of Sakinaw Lake sockeye (Ruby Creek spawning area, Murray and Wood 2002). Spawning escapements of this population have declined dramatically during the 1990s (Figure 4.3). Most spawning populations before the 1990s exceeded 1,000 sockeye, but since then the returns have been a few hundred or less, even down to a single spawner recorded in 1998.

Figure 4.3. *Sockeye spawning escapement estimates for Sakinaw Lake (Ruby Creek) as recorded in escapement records (Murray and Wood 2002). The vertical axis is scaled in powers of 10 in order to present the range of values recorded from 1 (1998) to 16,000 spawners (1975).*



Furthermore, a sockeye population depressed to only tens of spawning fish and in a highly developed area such as the Strait of Georgia, is at considerable risk of extinction. Consequently, if this population were to be listed under the new Canadian Species at Risk legislation, the federal government would be required to develop a recovery plan to protect and rebuild it. Such plans could involve costly initiatives, in terms of habitat restoration, alterations to fishing practices, and restrictions on development. Given the likelihood of these future costs, there is substantial value in improving our assessments of these sockeye populations and ensuring their immediate protection.

Sockeye in the Strait of Georgia are quite diverse, although the basis for assessment is relatively weak. The returns to most streams are depressed from past levels. This situation has a serious potential effect under the federal government's draft Wild Salmon Policy and the Species at Risk legislation. Individual sockeye populations are likely to be identified as single conservation units and require specific conservation plans if they are judged to be at risk. The Council recommends that the stock status of these small populations be more carefully examined, and a framework for quantitative assessments be specified.

4.2 Strait of Georgia Pink

The status of pink salmon in the Strait of Georgia is not easily determined. Pink salmon have been recorded to spawn in 115 streams from Statistical Area 12 (lower Queen Charlotte Sound) through to Area 20 (southern Vancouver Island around to Renfrew), excluding the Fraser River populations. Unlike Fraser pinks, their spawning occurs in both the even and odd years (Fraser pink salmon only return during odd years). However, essentially all the non-Fraser enumerations are based on visual estimates, and catches cannot be assigned to individual populations since they historically occurred in large mixed-stock fisheries. In odd-years, these populations are caught with Fraser River pinks. The Pacific Salmon Commission estimates the catches of Fraser and non-Fraser pinks, but the catch of non-Fraser pinks is not allocated to individual spawning populations. Any assessments are further complicated by the unknown accuracy of the visual escapement surveys and inconsistency of inspections from one year to the next.

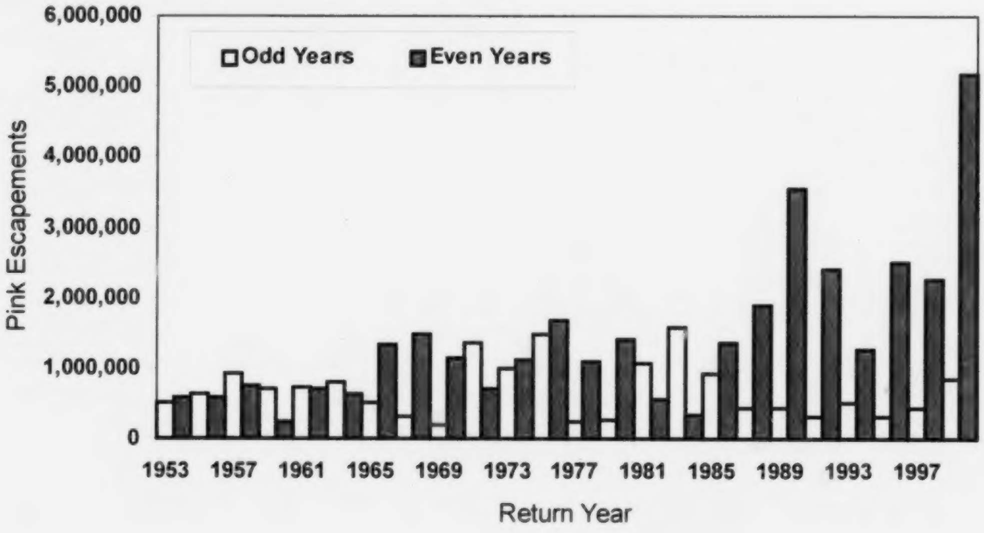
In general, pinks are distributed in the northern half of this region and production from the even-year line dominates. Even and odd-year pink salmon utilize streams down to the Englishman River on the east coast of Vancouver Island but the presence of pinks is very limited south of that point. Along the mainland shore, odd-year Pink salmon obviously are abundant into the Fraser River, but even-year pink salmon are limited south of the Phillips River (Phillips Arm, mid-Johnston Strait). Spawning channels in the Glendale and Kakweiken rivers and hatcheries in the Quatse, Quinsam, oyster, Puntledge, Sechelt and Seymour rivers are also credited with significant production of pink salmon since the early 1980's..

At this time, the PFRCC only reviews the existing spawning escapement records over time (available since 1953) and between river systems. Information on total production or productivity of populations is not currently available, with the exception of some data on survival rates of hatchery-reared pink salmon. The absence of harvest information creates uncertainty in the data presented and our summaries, but for now, it is apparent that:

a) major reductions in harvest rates have occurred recently and fisheries have been very limited in southern BC, so spawning escapements are the only source of information; and
b) harvest rates were larger in odd-years since Strait of Georgia pink salmon were mixed with Fraser River pinks and in fisheries targeted on that stock.

The effect of changes in harvest rates is evident when even and odd-year pink spawning escapements are summed over rivers but within years (Figure 4.4). Reductions in catch exaggerates any change in total stock size over time, since the escapement in recent years will be a substantially greater portion of the total production as compared to the situation before the 1990s. The absence of catch data, however, is not likely to account for differences between lines within time periods (i.e., note the poor escapements of odd-year pinks since 1987 but increased escapements in the even-year line since then).

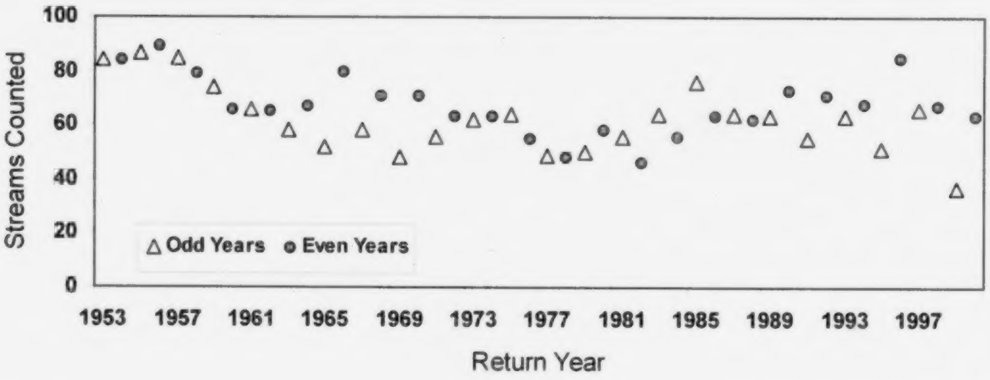
***Figure 4.4**. Total numbers of pink salmon spawning in the Strait of Georgia region, excluding the Fraser River. Returns are identified by even and odd-years or lines between 1953-2000, returns for 2001 are not yet available for all rivers in the region.*



The difference between lines could be caused by a difference in the number of streams that are enumerated annually. If only half of the streams were examined in odd-versus-even years, then a simple summation over streams would likely be less in the odd-year line. The difference in the number of streams enumerated, though, has not been consistent enough to account for the difference in pink spawning escapements between odd and even years (Figure 4.5).

An alternative explanation could be that different streams contribute to the production in the even and odd years. Comparing production by streams in even and odd years indicated, that in essentially all cases, the contributing streams are the same but the number of spawners is frequently much greater in the even year line (especially in the northern portion of this region).

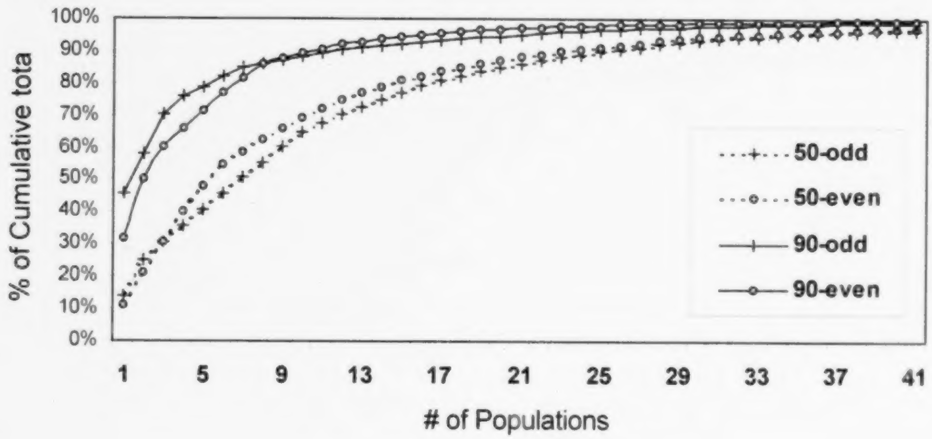
***Figure 4.5**. Total number of streams enumerated for pink salmon escapements. Values are coded to be consistent with the lines in Figure 4.4 (2001 is not included).*



However, the importance of specific streams to production within lines has changed over this time period. Comparisons have been made of average levels of production by stream during the 1953 to 1960 period(four spawning years per line) versus the most recent decade of production (1991-2000). Average levels of production were estimated for even and odd-year lines and each stream was then ranked in order from largest spawning escapements to smallest. An individual stream may have a different rank in a time period and line, but the intention of this approach was to examine the distribution of spawning escapements across pink salmon streams. If many streams used to contribute to the spawning population, but now very few streams do so, then this analysis would reveal a loss of diversity between populations and indicate greater risk of loss, since only a few streams now support pink spawning. In Figure 4.6, this situation is illustrated by the 1990s curves moving to the left, relative to the 1950s curves, indicating that fewer streams provide most of the spawning pink salmon.

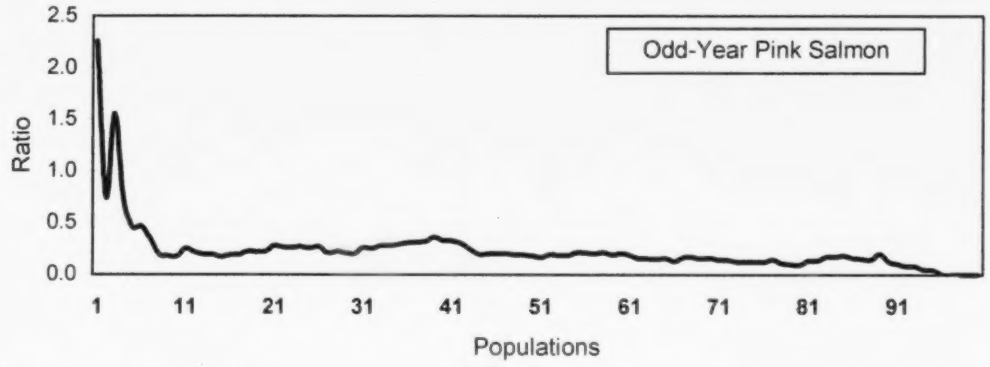
The major difference between time periods is the concentration of production in fewer larger populations during the 1990s, in both the even-year and odd–year lines (Figure 4.6). During the 1950s, about twenty-five streams accounted for over 90% of the total pink production in both lines. However, by the 1990s, only eleven streams accounted for 90% of the total production, and total spawning escapements had decreased by 40% in the odd-year line but increased by 500% in the even-year line.

***Figure 4.6**. Cumulative total production per spawning stream expressed as % of the total production for the 1950s even and odd-years versus the 1990s even and odd-year lines.*



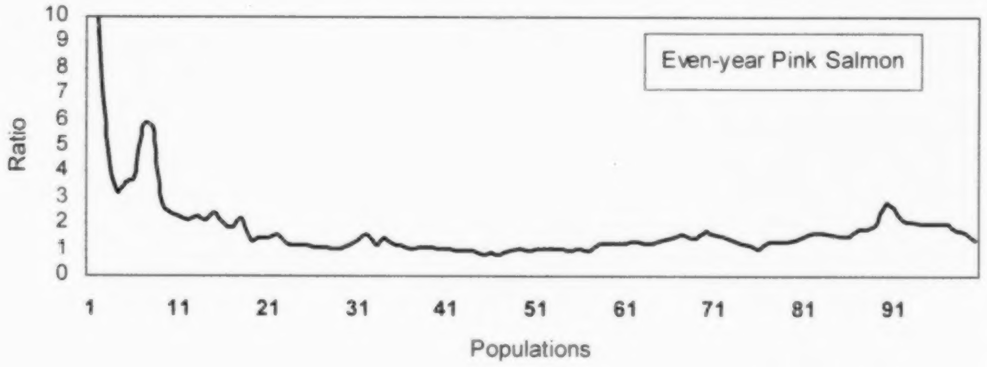
Are these changes in total escapements attributed to a few populations, or are they a more general feature of these pink salmon populations? A simple comparison between escapement sizes for each rank level indicates that the reduction in odd-year escapements occurred across all population sizes, except for two of the largest three populations (Figure 4.7).

Figure 4.7. *Ratio of changes in spawning escapement levels by rank order and for the odd-year line only (e.g., size of the 10th ranked population in the 1990 odd-year line divided by the 10th ranked population size in the 1950 odd-year line only).*



Values less than 1.0 indicate that the 1990 escapement sizes were less than the size of the 1950 escapement sizes for the same level of ranking. The same comparison for the even-year line demonstrates a distinctly different result, as essentially all levels of ranking involved larger populations during the 1990s (Figure 4.8). Essentially all of these ratios exceed 1.0, indicating that populations sizes were larger during the 1990s period than during the 1950s (a general increase across all escapement sizes).

Figure 4.8. *Ratio of changes in spawning escapements levels by rank order for the even-year line only.*



During the 1990s, spawning escapements in the ten largest single populations have accounted for nearly 90% of the total escapement in both the even and odd-year lines (Table 4.2), but in terms of numbers of spawners the odd-year line has been only about 20% of the even-year line.

***Table 4.2**. Largest 10 spawning populations during the 1990s for even and odd-year pink salmon in the Strait of Georgia region.*

Top 10 Even-year Populations	Area	Top 10 Odd-year Populations	Area
1. Kakweiken River (enhanced)	12	1. Glendale Cr. (enhanced)	12
2. Glendale Cr. (enhanced)	12	2. Kakweiken R (enhanced)	12
3. Phillips River	13	3. Quinsam R (enhanced)	13
4. Ahnuhati River	12	4. Puntledge R (enhanced)	14
5. Wakeman River	12	5. Oyster River (enhanced)	14
6. Salmon River	13	6. Ahnuhati River	12
7. Adam River	12	7. Salmon River	13
8. Quinsam R (enhanced)	13	8. Skwawka River	16
9. Kingcome River	12	9. Apple River	13
10. Ahta River	12	10. Tsolum River	14
Percentage of total production Accounted for ...	89.5%	Percentage of total production Accounted for ...	88.5%

Without more detailed examination of total production and productivity, what can be concluded from these analyses? It can be stated that:

- production of non-Fraser odd-year pink salmon in the Strait of Georgia region has declined since the 1950s; the reduction occurred in most populations; and at present over 50% of these populations have annual average escapements of fewer than 200 pink salmon (estimates usually based on visual counts only);
- spawning escapements of non-Fraser even-year pink salmon in the Strait of Georgia have increased significantly in the past decade, but approximately one-third of these populations also have annual average escapements of less than 200 pink salmon; and,
- the total number of streams supporting spawning populations has not declined significantly, but the majority of the spawning pink salmon are now concentrated in fewer large populations.

The information available for Strait of Georgia pink salmon limits the assessment of these stocks and precludes any further comment on the differences noted between even-year and odd-year pink. The co-incidence that the odd-year line is depressed and in the same return years as Fraser River pink salmon suggests that harvest impacts may be involved, but recent reductions in fisheries suggest that this is not an adequate explanation. The consistency of this difference between years and within streams is potentially an important issue for research.

4.3 Strait of Georgia Coho

Coho salmon are widely distributed through out this region, and natural production from these populations is extensively mixed with production from ten major enhancement programs and numerous community programs. The production from these natural and enhanced populations became a mainstay of the recreational fishery within the Strait during the 1980s. However, by the late 1980s, it became apparent that the total exploitation on Strait of Georgia coho exceeded the level that was sustainable by natural coho populations (Anon. 1990). Estimates of the sustainable exploitation rate for wild coho populations were between 65-70% but actual exploitation rates were commonly 10+% greater than these values (Figure 4.9). The situation worsened when ocean productivity and marine survival of coho salmon declined in the 1990s (Figure 4.10). The impact of reduced survival is that the productivity and the sustainable exploitation rates on these coho salmon also decline. Unfortunately, the lag time between detecting and responding to the decrease in productivity resulted in a period of increased over-fishing on these coho stocks.

***Figure 4.9**. Portion of the total adult return that were caught in ocean fisheries on indicator stocks of coho salmon in the Strait of Georgia for catch years of 1983 to 2000 (estimates for 2001 are not yet available).*

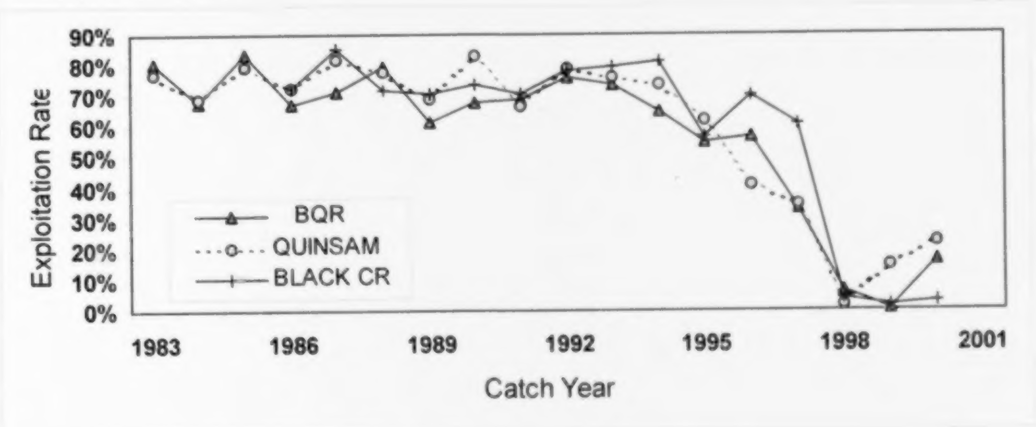
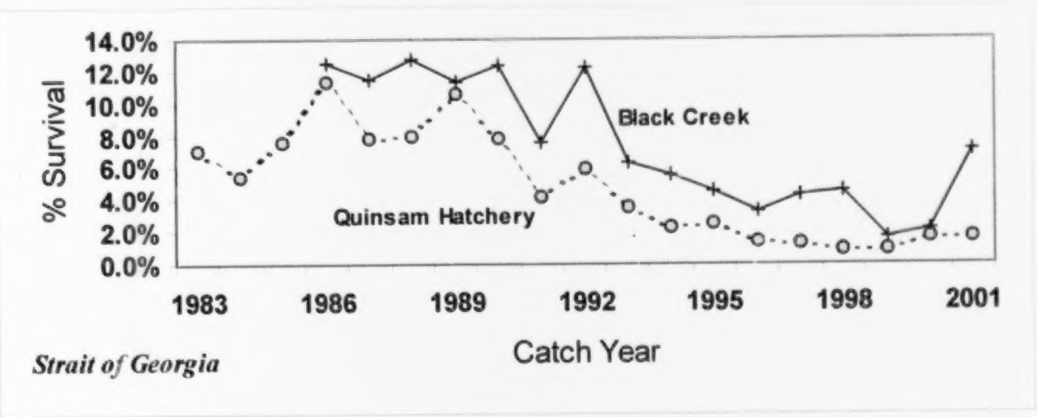


Figure 4.10. Marine survival rates of coho entering the sea to recoveries as adults in fisheries and the spawning escapement in the next year. Data for a hatchery indicator (Quinsam Hatchery, Campbell River) and the natural stock indicator at Black Creek, near Campbell River. Data is presented for the same years as in Figure 4.9.



As previously discussed for Fraser River coho salmon, the combined effects of habitat changes, over-harvest in large mixed-stock fisheries, and declines in the survival of coho in the ocean all contributed to a major loss of coho production during the 1990s. Once the severity of the impact was realized, the coho conservation plan was established, including a closure of southern BC coho fisheries (with the exception of incidental mortalities in some fisheries) since 1998.

In these coho figures, catch year information is presented so that comparisons can be easily associated with calendar years. However, essentially all of these coho mature at 3-years and enter the sea as yearling smolts (after one full year of rearing in fresh water). To compare years of coho spawning or freshwater production, the associated spawning years (brood years) are 1980 to 1997, and juveniles would entry the sea (as smolts, the life phase that migrate to sea) in the spring of years 1982-1999. Coho salmon are an opportunistic species that utilize a wide variety of habitats (streams, pond, lakes, large rivers), all of which exist in the Strait of Georgia region. Coho also tend to return to freshwater natal streams in the late fall when coastal environments tend to make their enumeration difficult. Consequently, fisheries management agencies on the coast identify specific populations or "indicator stocks" to represent all coho in a geographic or habitat range. Simpson et al. (2001) provide a good description of the coho indicator stocks used in the Strait of Georgia. In the figures above, Quinsam and Big Qualicum stocks are hatchery-reared populations that have a long time series of coded-wire tagging that enable estimations of marine survival and fishery exploitation rates. The Black Creek stock is the only long-term natural stock indicator that is actually in the Strait of Georgia. Fisheries & Oceans Canada also maintains annual spawning escapement surveys for many other natural streams, but these surveys are usually visual inspections and of varying methodology, consistency, and accuracy. These data are considered useful in monitoring trends in coho spawning escapements over time, and they track directional changes in production based on the indicator stocks. Table 2 summaries these annual surveys of all systems in the Strait of Georgia region by population size (simply based on a subjective definition of over 500 spawners on average during some portion of the 1953-2001 time period) and by time intervals. These data summarize surveys of 281streams where coho have consistently been observed. In addition, there are 58 streams that have infrequent records of coho presence (only a few years in the entire time period).

***Table 4.3**. Summary of spawning escapement records for coho salmon in streams adjacent to the Strait of Georgia and Johnstone Striat (Areas 12 through the Strait portion of Area 20, Areas 28 and A29B in the lower Fraser River). For each time period, the average number of coho spawners recorded and the average number of stream inspections per stream are presented. The 1998-2000 time period was isolated from the 1990s decade since these are the years of major fishery closures. N = the number of different streams with escapement records during the period.*

	1953-1960	1961-1970	1971-1980	1981-1990	1991-1997	1998-2000
Average # of spawners in Large systems, >500	3,200	2,700	2,200	1,300	850	2,000
Average frequency of inspections	N=106, 96%	N=107, 92%	N=103, 86%	N=105, 67%	N=94, 63%	N=82, 73%
Average # of spawners in Smaller systems, <500	140	150	120	80	120	140
Average frequency of inspections	N=93, 76%	N=99, 68%	N=115, 65%	N=151, 56%	N=130, 46%	N=93, 67%

For example during the 1961-1970 period, the average number of spawners estimated for the larger systems was 2,700 coho per year and stream; there were 107 different streams with recorded escapements, and these were inspected on average in 9.2 of the 10 years (typically over the 107 streams). By the 1991-1997 period, the average escapement had declined to 850 coho per year and stream over the 94 streams that were surveyed. Furthermore, the rate of inspection had decreased to about 6.3 times in 10 years. The major source of decline in inspections during that period occurred in a few areas that simply did not record coho escapement in most streams after 1994. Following the harvest reductions during 1998-2000, the average escapement increased but the number of streams surveyed decreased again.

While these data may seem reassuring that large numbers of streams are being inspected in most years, and that the trend in the average seems to be consistent with the indicator stock information, such a conclusion should be drawn only with caution. The values are usually based on visual counts during late fall conditions, and methods of the surveys vary over time and streams. The number of streams surveyed in a year peaked during the 1981-1990 period, and none of the periods account for the complete 281 different streams recorded to have coho salmon spawners. Consequently, different streams could contribute to the average values in any year. The effect of this situation was greater for the smaller systems, since their annual coverage is much more variable (Figure 4.11). During the period 1953-2000, there were 48 years of escapement surveys. For all 281 streams, Figure 4.11 indicates what the frequency of surveys were for large and small coho systems. Clearly, the consistency of survey coverage was greater for large systems (only 11% of streams surveyed less than 1 in every 2 years). Coverage of the small systems is more variable and about 67% of the streams were surveyed less than one-half of the time.

The most notable problem in monitoring coho salmon in this region is the role of enhancement and its effect on the trend in escapements. Since the early 1980s, nearly 200 enhancement activities (defined by stream or hatchery designation) for coho salmon have attempted to increase coho production in this region. Programs have included major hatcheries, smaller community hatcheries, side channel restoration, and sea-pen rearing. The returns from these programs are included in Table 4.3 (excluding any returns to hatchery facilities) and at least one third of the large systems are involved with enhancement programs. Consequently, the observed trends may not represent the situation in streams that involve only the natural coho spawning and rearing.

***Figure 4.11**. Number of streams by size category and the frequency of surveys in each stream (percentage of years surveyed, number of years = 48) for coho salmon in the Strait of Georgia Region.*

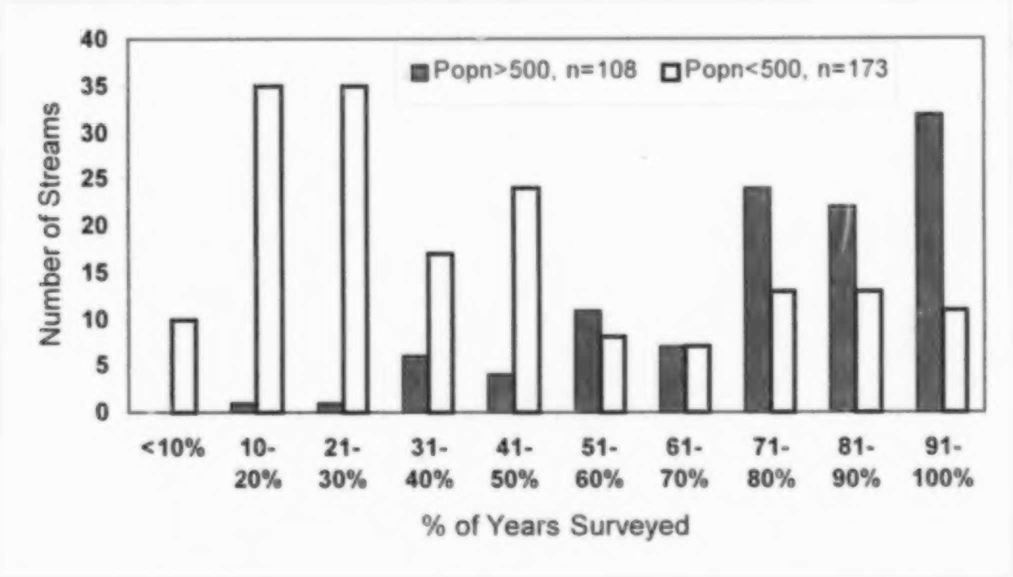
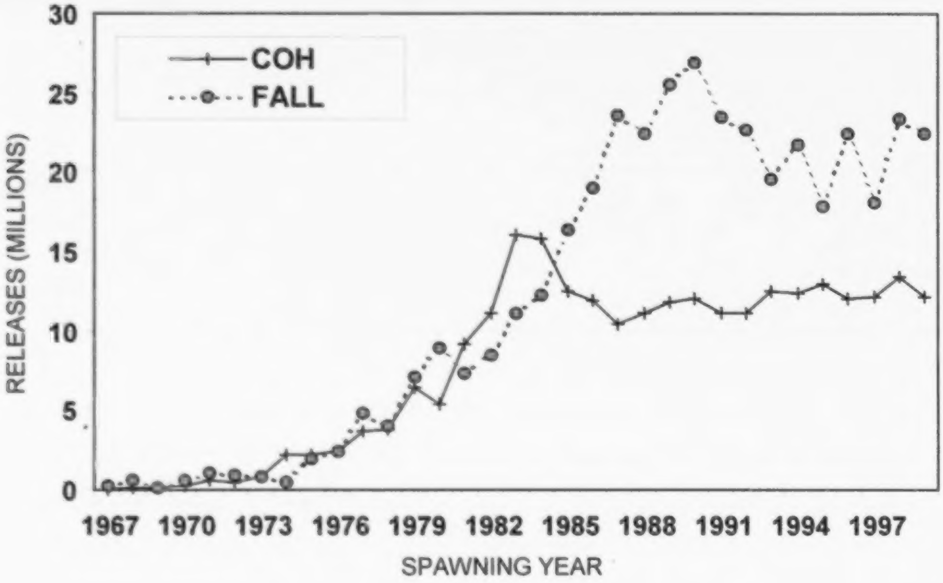
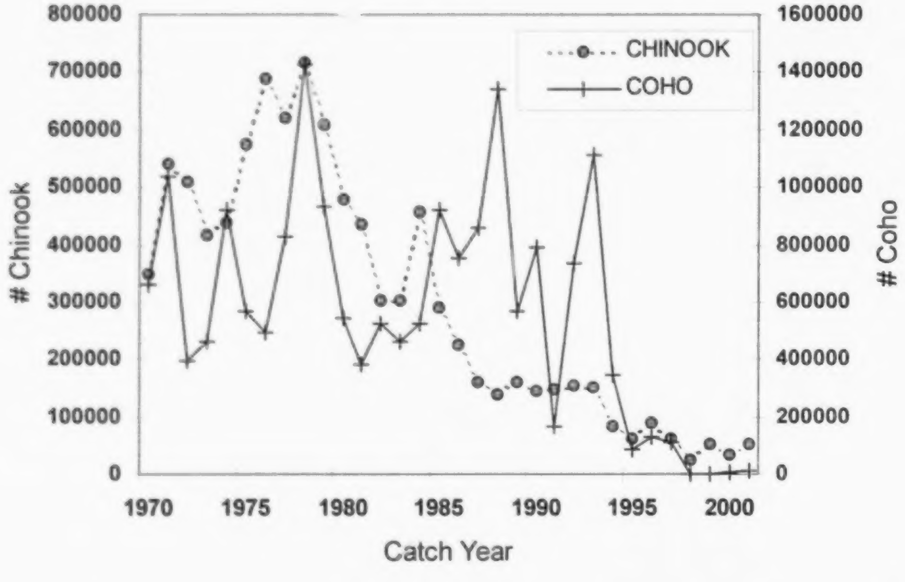


***Figure 4.12**. Release of fall chinook salmon and coho salmon (all stages except unfed fry) from Canadian enhancement facilities around the Strait of Georgia, 1967-1999 spawning years. (Very few spring chinook are only released in the Nanaimo River)*



It is important to note that even after large investments in enhancement and the annual of release of millions of chinook and coho salmon around the Strait of Georgia (Figure 4.12) that coho spawning escapements declined and fisheries were eventually closed (Figure 4.13).

***Figure 4.13**. Historical catch of chinook and coho salmon in the Strait of Georgia commercial troll and recreational fisheries, 1970-2001.*



While the difficulties in enumerating coho salmon adults are widely known, a shift to more indicator stocks to provide better information would be very expensive. In order to supplement information on the natural populations, Fisheries & Oceans Canada implemented juvenile coho surveys (beginning in 1991, see Simpson et al. 2001). These surveys monitor the density and size of coho in streams around the Strait of Georgia and lower Fraser River during the early fall. In general, there is a significant positive relationship between adult spawning escapement and juvenile density (r^2=0.57, n = 10 years, Simpson et al. 2001). Neither of the adult counts nor the juvenile estimates are necessarily accurate in terms of total coho production, but they tend to corroborate each other and strengthen the assessment of trends in Strait of Georgia coho production.

Fisheries & Oceans Canada's ability to assess coho salmon in the Strait of Georgia region improved notably through the 1990s. For the most part, management actions taken were appropriate and consistent with the productivity and production of these stocks. Excessive exploitation rates coupled with inter-annual variations in the distribution of Strait of Georgia coho salmon (Beamish et al. 1999) and very poor marine survival had depressed coho production to the extent that decisive actions were required.

While coho production now seems to be improving, there are concerns for the continued ability to assess coho salmon and for the interactions of hatchery coho with naturally-produced coho. The use of indicator stocks that are capable of monitoring freshwater productivity (smolts produced per spawner) and estimation of survival and exploitation in the marine environment are essential to establish an understanding of the dynamics of coho salmon. At the same time, it should be acknowledged that even the use of indicator stocks has uncertainty associated with how representative each stock really is (Labelle et al. 1997). Indicator stocks detect important changes in these parameters, but the uncertainty about abundance of hatchery coho requires further research. Hatchery-produced coho now constitute the majority of this stock in the Strait of Georgia. Over the past three decades, the proportion of hatchery coho in the Strait of Georgia has increased from a few percent to over 70 percent (Sweeting et al. 2002). Unfortunately, while millions of coho are released from Canadian hatcheries (Figure 4.12) the abundance and catches of coho in the Strait have not increased. The combined effect of reduced total abundance and increased proportions has stimulated the hypothesis that natural coho have been replaced by hatchery-produced coho. These interactions may be most critical during periods of reduced marine survival when the total production of coho would be limited. While there are now surveys of coho abundance and the proportion of hatchery fish in the Strait of Georgia, no research is being directed at this issue.

The broader issue of sustaining biodiversity or ecosystem function in streams requires a different assessment approach. This would include a wider geographic or habitat-based survey to monitor coho distribution. The variability between years in streams that were surveyed, as noted above, suggests that the current surveys are inadequate as they confound the surveyed streams with inter-annual variation within streams.

The Council continues to support a precautionary approach to management of Strait of Georgia coho salmon to enable these stocks to recover. It recommends attention to two future requirements for coho in the region:

1) establishment of a reliable assessment framework for the naturally-spawning coho populations, including monitoring of hatchery adults in these systems; and,
2) increased research into the ecological consequences of interactions of hatchery and wild coho salmon.

As ocean production of coho improves, the demand for the demand for coho fisheries in the Strait of Georgia will likely resume, including the use of mark-selective fisheries on hatchery-produced coho salmon. The conservation of wild coho in the coming years will require an assessment framework that monitors the dynamics and diversity of these populations, and studies their interactions with hatchery fish. Not every stream can be surveyed every year, but the data from consistent and repeatable surveys are clearly needed.

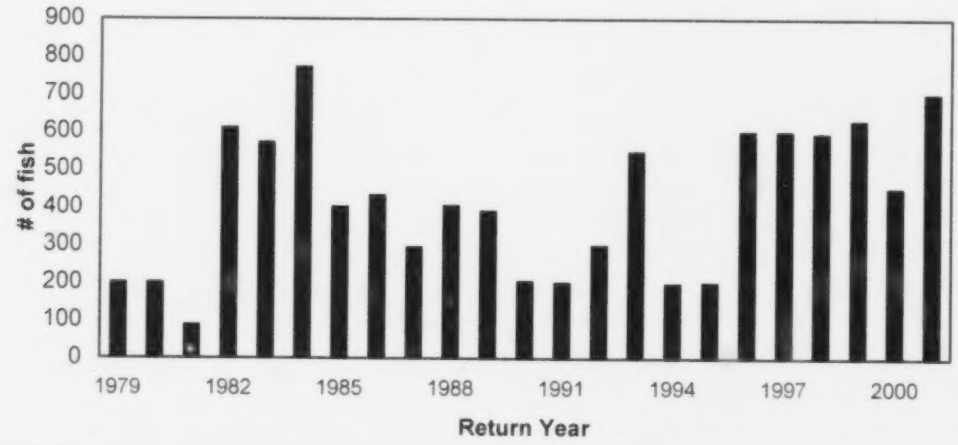
4.4 Strait of Georgia Chinook

Chinook utilize many of the medium to large rivers in the Strait of Georgia region and are produced extensively in hatcheries and spawning channels. Four varieties of chinook are recognized in the region, two of which are now represented by only a single population:

i) Spring run-timing chinook, yearling smolts, returning to natal streams in spring through early summer (Nanaimo River springs, Figure 4.14);
ii) Summer run-timing chinook, juveniles migrate to the sea in their first summer, adults return in July (Puntledge R. summer chinook, Figure 4.15);
iii) Mainland Inlet, summer chinook, juveniles may migrate to the sea in their first summer but usually second year, and under-yearling hatchery smolts, returning to terminal areas June through early August (large mainland inlet rivers and Tenderfoot Hatchery in the Squamish River,); and
iv) Fall run-timing chinook, juveniles migrate to the sea in May/June of their first year, and adults return in August through September (most common variety).

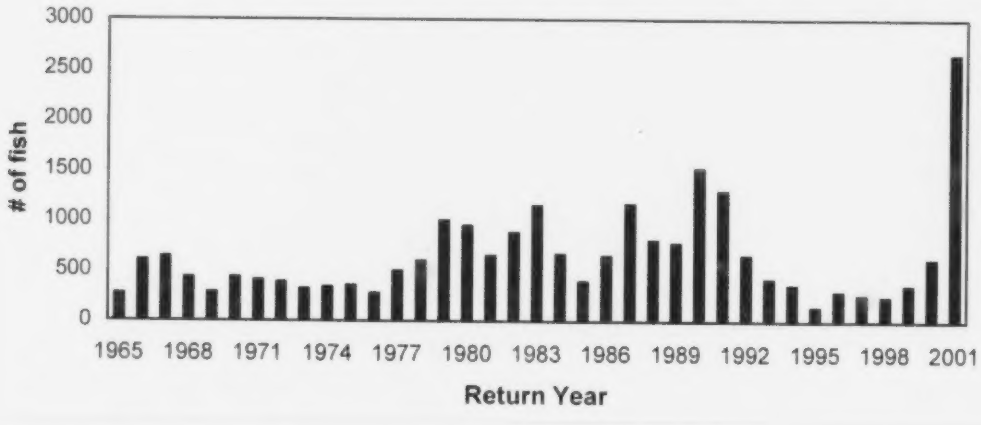
Spring chinook returning to the Nanaimo River (Figure 4.14) is the only known spring stock remaining in the Strait of Georgia, but it is uncertain whether or not spring chinook still exist in the larger mainland inlet systems. Nanaimo spring chinook utilize the upper river and are able to hold in the canyon and Nanaimo lakes through the summer. Assessment of the stock has not been extensive, but annual escapement surveys are considered adequate as an index of annual changes. Recent levels of production have improved to several hundred adults per year. Natural production of Puntledge summer chinook was likely impacted by the Comox Dam and production has been limited for many years in spite of the spawning channel built in 1965 (Figure 4.15).

***Figure 4.14**. Estimated numbers of spring chinook returning to the upper Nanaimo River, 1979-2001. Returns are from naturally spawned and hatchery–reared parents.*



The substantial increase in Puntledge River summer chinook returns in 2001 is believed to be due to improved survival in the ocean. The Puntledge River also supported a run of fall chinook salmon, but a likely combination of over-exploitation and habitat impacts in the lower river resulted in its loss by the mid-1980s. Fall chinook returning to the Puntledge today are a mix of Big Qualicum and/or Quinsam fall chinook that were re-introduced to that system.

***Figure 4.15**. Estimated numbers of summer chinook returning to the Puntledge River, 1965-2001. Returns are from parents spawning in-river and in the artificial channel.*

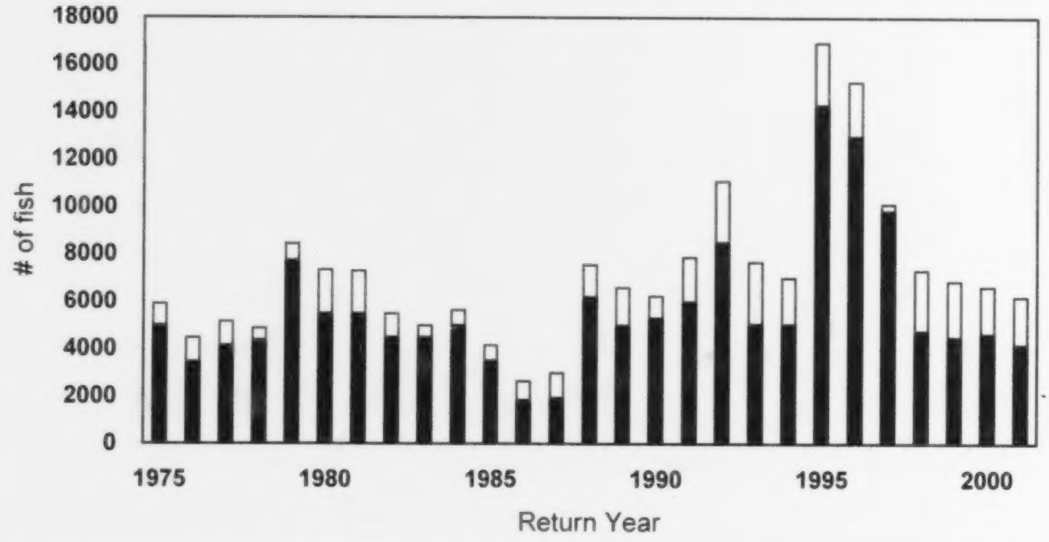


The majority of chinook production from the Strait of Georgia (excluding the Harrison and Chilliwack white fall chinook salmon produced in the lower Fraser River) are fall run-timing populations returning to the major hatcheries and to several rivers. The most notable natural system is the Cowichan River (Figure 4.16). Fall chinook salmon have been reared and released from about 40 different enhancement programs since the early 1980s and are produced in each of the major hatcheries.

The most northerly population in this region is the Nimpkish River fall chinook. This population used to be comprised of three spawning sub-populations: one at the outlet of the lake; another at the outlet of the Anutz/Atluck sub-basin (flows into upper Nimpkish Lake); and the main one in the Woss and upper Nimpkish rivers (Weinstein 1991). The latter, however, is the remaining spawning population. Currently its escapement is recorded as several hundred spawners, but well down from the thousands of Nimpkish spawners in past years. Distribution of coded-wire tags for this stock suggests that it may be a unique stock that is locally distributed in central BC. Current efforts to restore production include a hatchery program, but recent escapement records do not yet indicate a significant production benefit from this program.

Information on the summer chinook in the mainland inlets is very limited, even for those returning to the Squamish River. Many of the mainland systems are large glacially-fed rivers that peak in flow during the return of many of the chinook. However, a recent program initiated in the Klinaklini River (and Devereux tributary) has estimated chinook returns of approximately 10,000 for the past three years. Historically, the returns to the Squamish River were substantially larger.

***Figure 4.16**. Total return of fall chinook to the Cowichan River system. Native in-river catch and brood stock used in the hatchery (cross-hatched), and chinook spawning naturally (solid bar) are summed to indicate the total return. Hatchery production began with the 1979 brood year and was substantially expanded in 1991.*

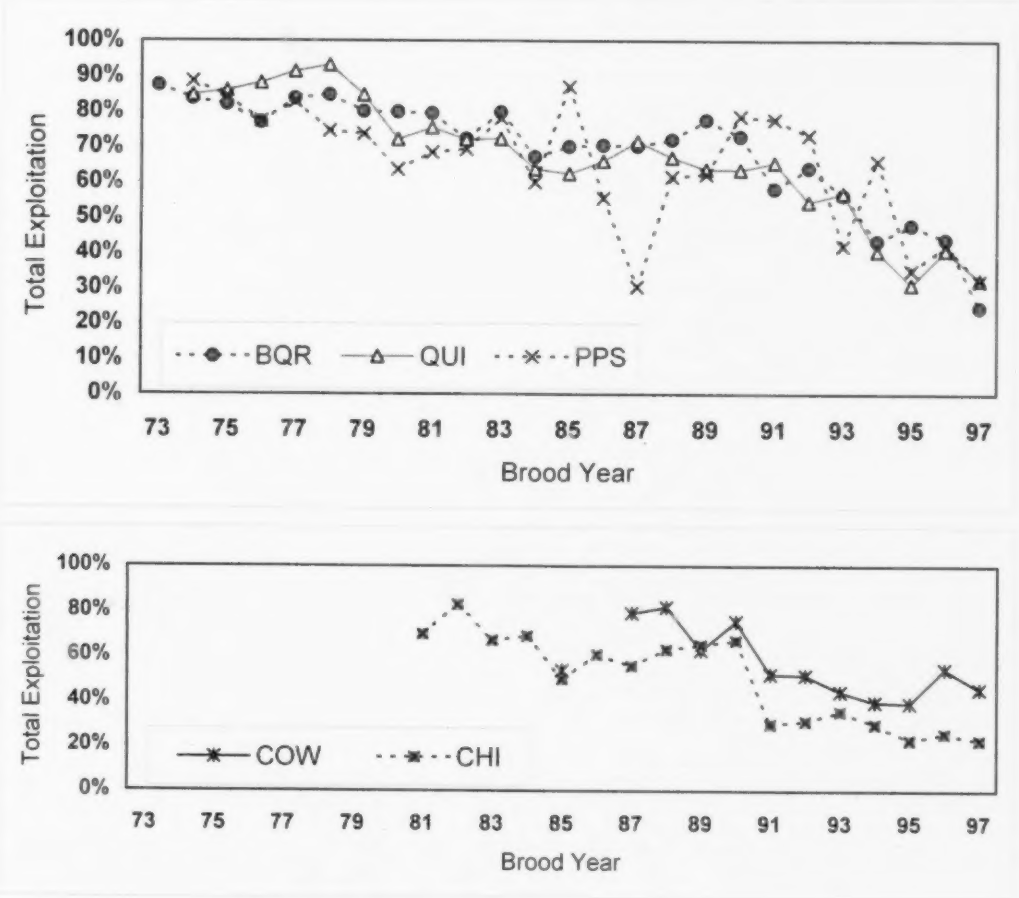


Management of chinook salmon from the Strait of Georgia has a complicated history. Each of the chinook life history types described above differs in their ocean distributions and the ages when they mature and return to their natal streams. Chinook feed in the ocean for between two and five years and may migrate further north to Alaskan waters. Their extended migrations and years in the ocean result in a sequential harvest and cumulative mortality due to fishing.

For example, Quinsam fall and Mainland summer chinooks are referred to as "far-north" migrating stocks since they have limited use of the Strait of Georgia after emigration from the stream, are extensively exploited in Alaskan and northern BC fisheries, and then are exploited in the Strait when they return as mature fish. However, fall chinook from the southern east coast of Vancouver Island and Puntledge summer chinook tend to use the Strait of Georgia extensively for rearing and a portion may not leave the Strait (based on tag returns from winter sport fisheries). The portion that emigrates from the

Strait does not show an extensive northern migration and tends to be caught in central and northern BC fisheries. Consequently, management of these chinook involves a wide variety of fisheries, both Canadian and American, and several age classes. Hundreds of varieties of chinook could be mixed in an ocean fishery and the impact of any one fishery is confused with the effects of many others. The cumulative effect of these problems was that most of these stocks were heavily exploited until new management regulations were implemented over the past 20 years (Walters and Riddell 1985). Total exploitation rates, based on coded-wire tagging of hatchery stocks, demonstrated that the fall chinook stocks were frequently exploited at over 70-80% through the 1980s (Figure 4.17). In these figures, year is expressed as the year of spawning or brood year since catch occurs over multiple calendar years. A fall chinook that reproduces in 1990, for example, would go to sea in 1991 and could be caught or return to spawn from 1992 through 1996. The total exploitation is the portion of adult production killed by fishing over the entire life span of these fish.

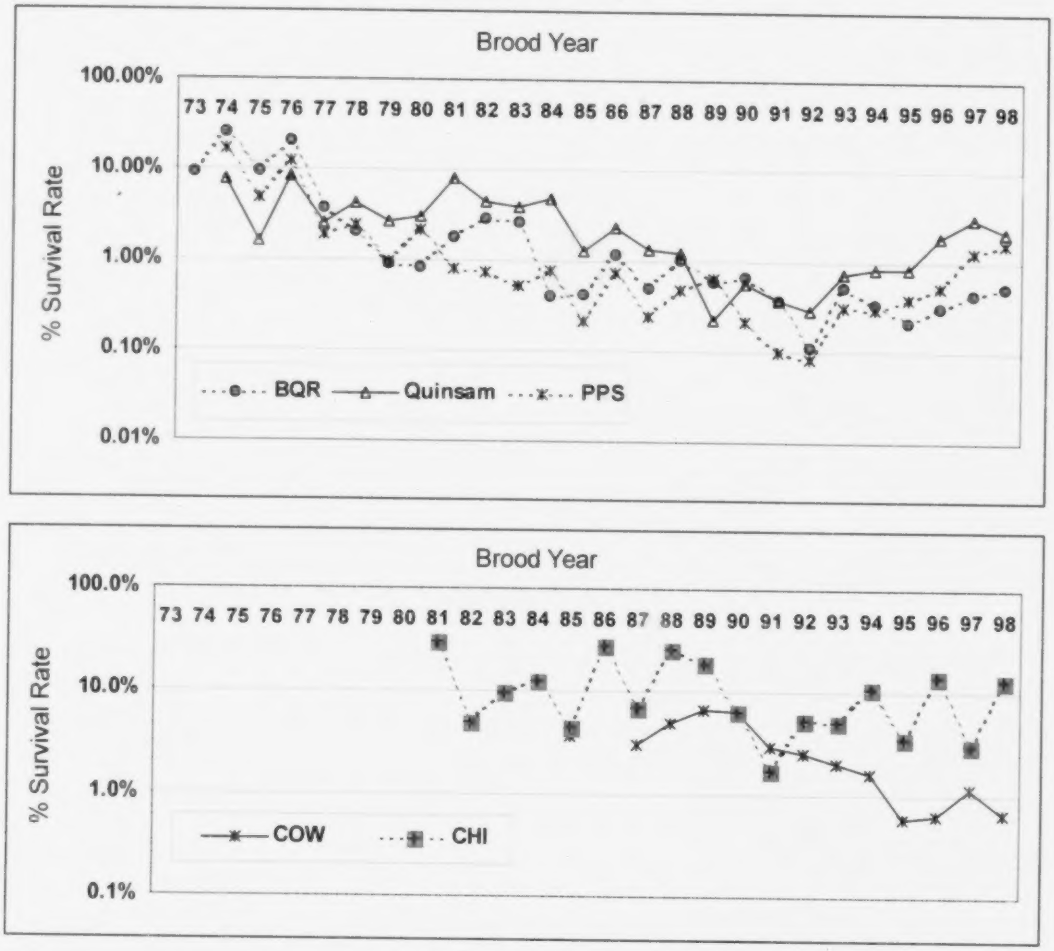
***Figure 4.17**. Total exploitation on tagged stocks of chinook in the Strait of Georgia. Stocks include BQR = Big Qualicum Hatchery, QUI = Quinsam Hatchery, Campbell River, PPS = Puntledge River summer chinook, COW = fall chinook, Cowichan River, CHI =fall, white-fleshed chinook, Chilliwack Hatchery, Harrison River stock.*



Although these stocks differ in their distributions at sea, the changes in exploitation rates are similar due to the broad scale of management actions in ocean fisheries. Notable changes in the exploitation of these stocks occurred following the 1985 Pacific Salmon Treaty, the 1999 amendment to the Treaty, and recent changes in ocean production due to poor marine survival in some areas of the coast. The rapid decline in exploitation rates during the late 1990s resulted from reduced fishing pressures due to low abundances in the Strait of Georgia fishing area, closures of ocean troll fisheries for conservation of coho and chinook salmon, and release of chinook from many Canadian net fisheries.

As with coho salmon, management of these chinook stocks must also account for variation in marine survival. Variation in survival of these stocks is much greater than for coho salmon. During the period monitored in the Figure 4.18, marine survival (measured as adult production divided by the number of chinook released) has varied by 300 fold, from 0.08% in the Puntledge River 1992 to 30% in the Harrison River in 1981.

***Figure 4.18**. Marine survival of the chinook indicator stocks*



The important feature of Figure 4.18 is the trend in marine survival and the similarity between these stocks. The pattern for Chilliwack differs since this lower Fraser River stock has a different pattern of ocean distribution and resides in a huge estuary when it goes to sea. The marine distribution of the Chilliwack chinook is in the Strait of Georgia, West Coast of Vancouver Island, and Washington State. The distribution of the other four stocks is more in northern Strait of Georgia, and central and northern BC. Survival of the Strait of Georgia stocks generally declined during the 1980s and 1990s and has only begun to recover in the most recent broods. The Cowichan stock, though, has not shown the recent recovery in marine survival rates.

The summary of this chinook review is similar to that for coho salmon. Although stock management in the Strait has tended to focus on coho salmon in recent years, the situation with ocean exploitation rates and marine survival were analogous for chinook. Again, the reductions in ocean exploitation rates (due to several stock management changes) enabled the spawning escapements to be sustained even in the presence of the poorest recorded period of marine survival.

The glaring need for assessment of these chinook stocks is in the mainland inlets. The large rivers could support substantial populations of chinook salmon, but those freshwater environments may limit production. Most of the systems are glacial rivers with very high sediment loads and braided channels. The exception to these conditions is the Devereux River in the Klinaklini drainage. This is a clear water system that has been monitored for chinook returns, but it is not representative of the chinook using the main river channels. The development of rigorous assessment programs in those channels would be costly and likely to have poor repetition between years. However, if ocean exploitation rates on other summer chinook stocks are conservative, then the early migration timing of these stocks should also limit exploitation on these stocks.

That may not be the case for Squamish summer chinook. Mature Squamish chinook return to the Strait of Georgia in mid-summer and are vulnerable to summer fisheries in the Strait of Georgia until they enter Howe Sound. The Squamish basin is potentially the largest chinook source in this region, but assessment of these populations has proven to be very difficult. Effective management and development of this stock could have great value, but a significant investment of resources would be required to quantitatively manage this stock. Fisheries & Oceans Canada has not directed the resources to conduct this assessment, except that chinook production from the Tenderfoot Hatchery is continuing, and annual tagging is part of that program. The current assessment programs in the Squamish River are inadequate to effectively manage this potentially important stock.

The Council notes two unique chinook stocks that exist within this region (Nanaimo River spring and Puntledge River summer chinooks), plus the Nimpkish River fall chinook, and are known to be substantially depressed relative to past levels of production. The status of chinook in the larger rivers of the mainland inlets is uncertain due to limited assessments. The majority of chinook production in the Strait of Georgia region is attributed to fall chinook, both naturally spawned and hatchery produced. Like coho salmon, however, hatchery production currently exceeds natural production and presents risks of mixed-stock fishery impacts on natural stocks.

Sustaining production of chinook salmon in the Strait of Georgia will require protection of freshwater and near-shore marine habitats, and monitoring of exploitation rates in fisheries. At present, there is only one indicator stock for naturally produced chinook in the Strait of Georgia region. Other monitoring programs are dependent on tagging of hatchery-produced juveniles. Such a limited assessment basis may suffice if harvest rates on stocks remain conservative. However, as marine survival rates and ocean abundance of chinook increase, it should be anticipated that fishing pressures will also increase. As with coho salmon then, the Council recommends the establishment of a reliable assessment framework for the naturally-spawning populations, including monitoring of hatchery adults in these systems and the diversity of chinook populations throughout this region.

4.5 Strait of Georgia Chum

As noted in the Fraser River section, chum salmon in southern BC are managed as a large spatial aggregate of populations, and the assessments of chum salmon are limited by a lack of population-specific catch information. Chum from northern Vancouver Island, the mainland inlets, the Strait of Georgia including the Fraser River, and Juan de Fuca Strait are referred to in aggregate as the Inner South Coast (ISC) chum stock. In total, this area includes more than 400 different chum populations with about 10% of them accounting for most of the total production, and with the Fraser River having the largest populations (Ryall et al. 1999, Anderson and Beacham 1983).

The ISC chum stock is divided into fifteen geographic regions for monitoring, but the northern-most (Seymour/Belize Inlet) and the southern-most (South Vancouver Island) are excluded from a sub-group referred to as the "Inner Study Area" (ISA) chum stock. The former two regions are not harvested in the Johnstone Strait, Strait of Georgia or Fraser River fisheries that are managed under the "Clockwork Management Plan" implemented in 1983 (Hilborn and Luedke 1987) or the Fraser River plan implemented in 1987 (Gould et al. 1991). These plans set allowable harvest rates based on the abundance of returning chum salmon and established spawning escapement goals to be achieved over the entire aggregate stock. When chum abundance was poor, harvest rates would be greatly reduced, but some limited access to fishing would continue. However, when chum abundance was good, the fishing rate could increase in that year. The intention of the plan was to allow the stock to rebuild through increased numbers of spawners, while providing some consistent access for fishing. The abundance is determined for the entire stock aggregate.

The extensive report by Ryall et al. (1999) provides a comprehensive review of the populations, fisheries, and enhancement of ISC chum stocks to 1997. For this annual report, however, that assessment has not been updated through 2001 since the escapement records for last year could not be provided, and an initial assessment of the data for 1998 and 2000 did not change any of the results presented by Ryall et al. Their report is available via the internet[11] or can be provided by the secretariat of the PSARC at the Pacific Biological Station, Nanaimo.

As a basic overview, the Council has updated catch and spawning escapement graphs for the ISA chum stock and the release of chum fry from all enhancement programs in the Fraser River and the Strait of Georgia. The spawning escapement data includes preliminary 2001 data, but final estimates of that year's spawning population sizes in the Harrison and Chehalis rivers were not available in time for this report.

Since implementation of the Clockwork Management Plan, spawning escapements (Figure 4.19a) have shown a general increase, but the annual observed values also vary with chum production. In recent years, for example, the annual return of chum has ranged from over seven million fish in 1998 to about one million in 2000.

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[11] www.dfo-mpo.gc.ca/sci/PSARC/ResDocs/diadrom_99.htm

Figure 4.19a. Total spawning escapements for Inner Study Area chum salmon (defined in text).

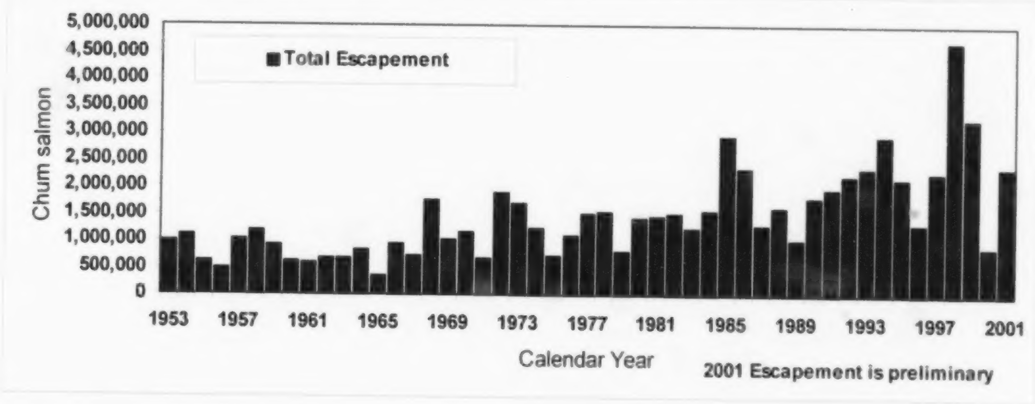
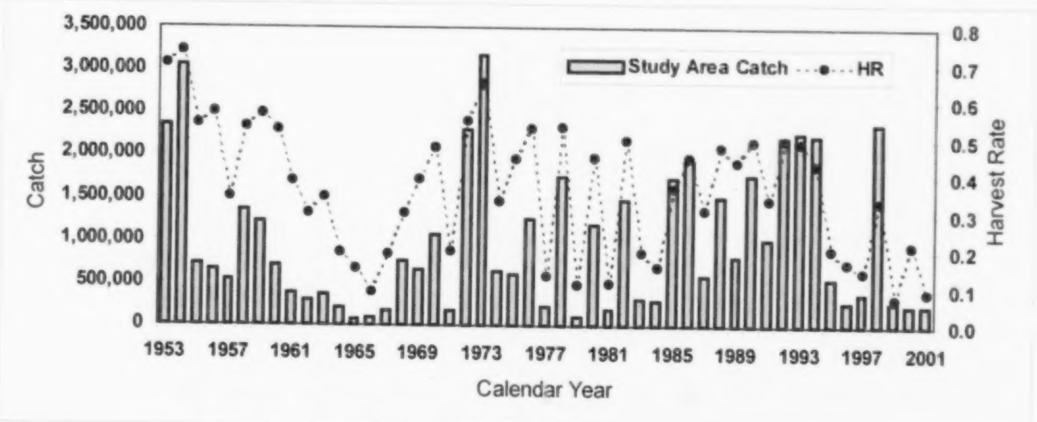


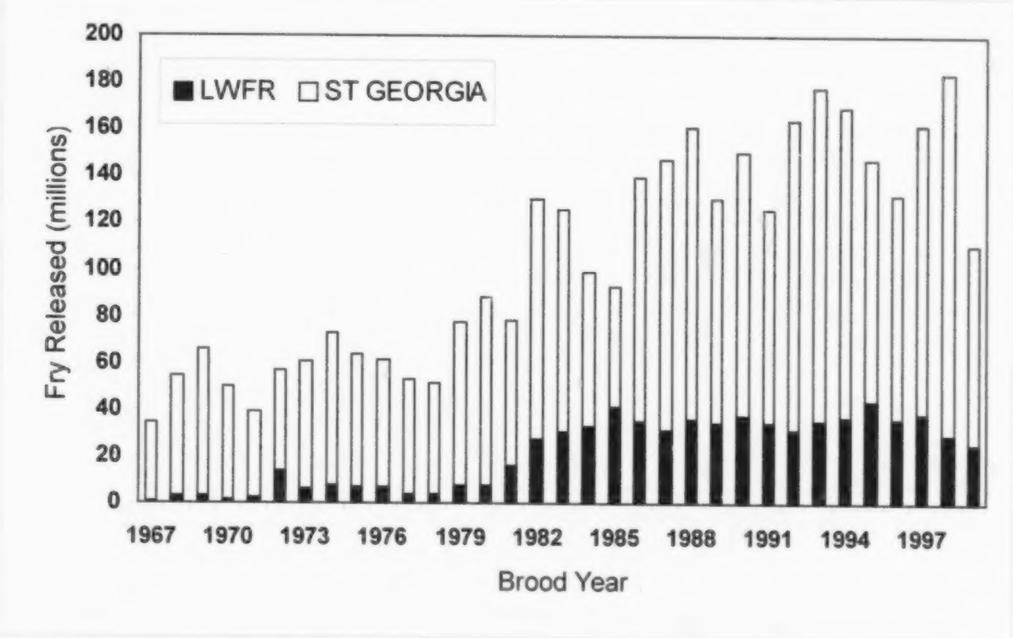
Figure 4.19b. Total catch of Inner Study Area chum salmon in all southern BC and U.S. fisheries, and the estimated annual harvest rate for this stock aggregate. Harvest rate is simply the proportion of the total production (catch plus spawning escapement) taken as catch in all fisheries.



Since implementation of the first Clockwork management plan in 1983, both the estimated annual harvest rate (averaging about 30%) on ISA chum stocks and the variability in rates between years has declined by about 25% (Figure 4.19b). Since the early 1980s, ISA chum production (total numbers of fish) has been greater on average than in the earlier years, particularly during the mid-1960s. Part of this increase in production is credited to chum released from the major hatcheries.

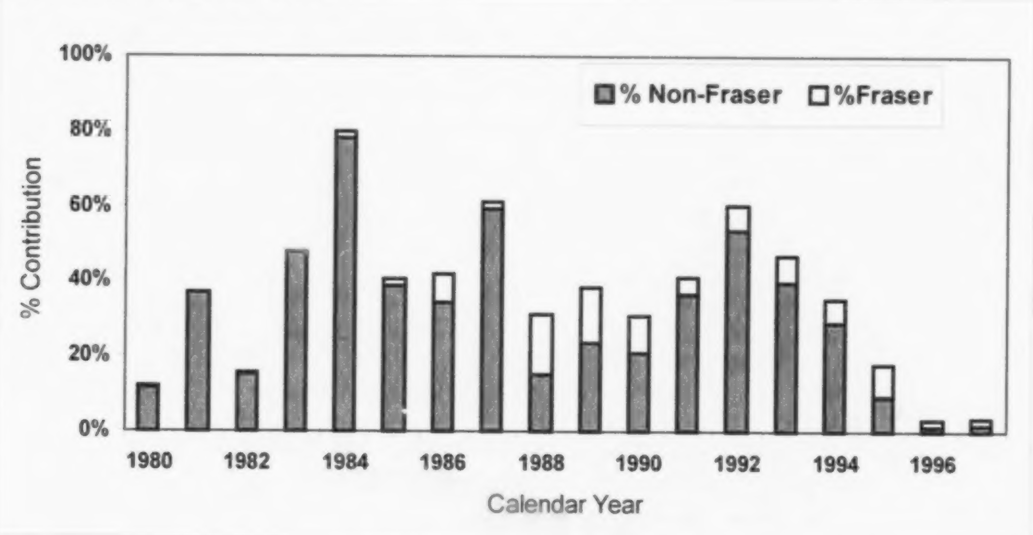
The first significant chum enhancement project at the Big Qualicum River (east coast Vancouver Island) was designed to increase freshwater survival by controlling flow and building a small artificial spawning channel. Adults were allowed to spawn naturally, but in controlled densities and protected flow conditions. Juvenile chum that hatch and emerge from the gravel move immediately downstream to the ocean. These migratory juveniles are referred to as unfed fry. An alternative enhancement strategy is to retain the emergent fry for a few weeks and feed them to increase the size of the migrants. This type of strategy is referred to as a Japanese-style hatchery producing fed-fry migrants. Both types of enhancement strategies have been used extensively in the ISA chum stock, particularly since the early 1980s. Chum hatcheries in the Fraser River are Japanese-style facilities, but most chum releases along the east coast of Vancouver Island are unfed fry (Fig 4.20).

***Figure 4.20**. Total release of chum fry (fed and unfed) into the Strait of Georgia. Releases are cumulative but identified by LWFR (lower Fraser River hatcheries, below Hope) and all others releasing fry into the Strait of Georgia.*



Data provided by the Salmonid Enhancement Program and included in Ryall et al. (1999) indicates that unfed fry survive at 50%-60% of the fed fry releases (assessed for 1978-1992 spawning years). Ryall et al. (1999) also provide estimates of the enhanced contributions to chum catch and escapements for the years 1980-1997. While these values vary substantially between years, the contribution of hatchery-produced chum salmon (those with markings from Strait of Georgia and Fraser River major facilities only) to commercial net fisheries on the ISA chum stock has averaged 36% through to 1997, the last reported year of estimates.

***Figure 4.21**. Estimated contribution of hatchery produced chum salmon to the Clockwork Management fisheries harvesting the ISA chum salmon stock, 1980-1997 catch years. Data from Table 3.2.1 in Ryall et al. 1999.*



While these data indicate that the enhanced production can be an important contribution to catch, their utility for much else is very limited. Similar comparisons for spawning escapement are of dubious value, because the non-enhanced stocks do not have comparable escapement surveys. It is known that large numbers of chum produced in these facilities spawn naturally in the associated streams, but relatively little is known about the extent of straying into non-enhanced populations. Furthermore, these contributions depend on where the fisheries were conducted. In many cases, terminal fisheries on enhanced stocks were used to reduce the harvest impacts on natural populations. For example, the fisheries are directed on chum returning to the Qualicum and Puntledge River facilities, or to harvest enhanced stocks with early to middle run-timing within the Fraser River. Given the magnitude of chum releases and the potential for mixed-stock harvest impacts on naturally produced chum in the ISA stock, this level of enhancement generates uncertainty about the current status of the natural production of chum in the ISA stock aggregate.

Ryall et al. (1999) provides a summary of assessments similar to that presented above for Strait of Georgia pink salmon. Their review questions the adequacy of the escapement enumeration system for stock assessment and the declining coverage of the numbers of streams surveyed. In particular, they comment on methodology, consistency of stream enumerations, and diversity of streams contributing to the total production of chum salmon:

- *There is concern regarding the inconsistencies in methodologies and the lack of effort directed to escapement enumeration. The methodology for most small (<10,000 spawners) is accomplished by walking the stream and counting the spawners. The methodology for larger systems has varied through time and had included aerial over flights, mark recapture programs, dead pitch surveys, and river floats. In some years there are no field observations or enumeration programs on some individual systems. In some areas there are no observations at all.* (Page 17)
- *Only 27 or 6% of the 423 chum stocks in the ISC have complete spawning escapement records from 1953 to 1997 and 129 or 36% of the chum stocks have from 30 to 44 years of escapement estimates. Most chum stocks (209 or 52%) have less than 18 years of observations. From 1953 to 1983 approximately 50% of the 423 chum stocks in the ISC were surveyed each year. Effort increased and peaked in 1985 at 65% of the systems surveyed. Since 1985 the effort has declined to less than 40% of the systems being surveyed each year.* (Page 17)
- *Changes have also occurred in the proportion of escapement contributed by each system to the total escapement … There has been a steady decline in the number stocks required to achieve 85% of the total escapement. Fifty stocks accounted for 85% of the total escapement in the 1950s, 34 in the 1960s, 33 in the 1970s, 28 in the 1980s, and 16 in the 1990s. In the 1990s the Harrison, Stave, and Chehalis rivers have accounted for 46% of the total escapement to the ISC. These are Fraser River stocks and all have some level of enhancement.* (Page 17)

Based on the data presented in Ryall et al. (1999), Appendix 3 summarizes the current status of the spawning escapements for chum salmon in the fifteen geographic areas that comprise the ISC chum stock aggregate.

While it is not possible to assess the status of these chum populations given only data on spawning escapements, the Appendix 3 table indicates one significant concern. If only the total spawning escapement to all ISC chum stocks were considered, then a strong trend towards increasing escapements would be evident. This does not, however, consider the differences between the geographic areas comprising the ISC stock aggregate. An examination of Appendix 3 indicates that five of the geographic regions (numbers 1 to 5) have a declining trend in spawning escapements, five regions have no trend or very uncertain information, and five regions support an assessment of increasing spawning escapements (numbers 7,9,11,13, & 14). Each of the regions showing a decline is in the northern portion of the ISC stock and may not benefit fully from the Clockwork management plan. However, as Ryall et al. also note, there may be several reasons, including localized habitat impacts that contribute to these trends. Without more critical information derived from the assessment of stocks in those areas, it is not possible to explain these differences.

Appendix 3 does not consider two other notable chum stocks. There are two "summer" chum stocks in this region: a July return to the Ahnuhati River (Knight Inlet), and an August return to the Orford River (Bute Inlet). Returns of Ahnuhati summer chums has decreased over the long-term, but returns of the Orford summer chum were increasing until the 1990s. However, there is no overall trend in these data since the 1950s, although escapements were much larger during the 1980s. These two stocks are the most southerly Summer chums known in BC, but there are apparently no specific activities in place to conserve them.

While the Council acknowledges the detailed assessment conducted by Ryall et al. (1999), the issue of declining escapement trends for the northern ISC stocks has apparently not been addressed. The Clockwork Management Plan has reduced the harvest rate on southern BC chum stocks when the aggregate abundance is reduced, but as with any mixed-stock harvest issue, the issue of differential stock impacts must be monitored and plans adjusted if problems persist.

Enhancement of southern BC chum has provided benefits to fisheries and reduced fishing impacts on some natural chum populations. However, the magnitude of chum fry releases and consequences for mixed-stock catches suggest that there is a need for further investigation of direct and indirect interactions with natural populations.

Furthermore, the Council notes that the only 2001 salmon production data that could not be provided for this report were the southern BC chum data. Staff responsible for these data noted the inability to provide final escapement estimates for a major population, the age structure for the 2001 catch, and the estimated contribution of enhanced fish to catch and escapement. Given the high inter-annual variability in chum production, these data are essential for timely assessments and development of management plans.

5. West Coast of Vancouver Island

The West Coast of Vancouver Island (WCVI) is the rugged barrier that shelters the inner Strait of Georgia region from Pacific storms (WCVI, Map 5). This region includes the hundreds of relatively short but steep rivers from Port Renfrew in the south to the tip of Vancouver Island. The region has a relatively low human population density, but has experienced extensive habitat impacts through industrial development. Possibly the biggest difference between streams in this region and others in southern BC is their highly dynamic environmental conditions. This report focuses on the freshwater conditions and the salmon populations, but the offshore area of WCVI is also an important and highly dynamic marine system that has large effects on the production of salmon from these freshwater systems.

The extent of the environmental differences between the West Coast of Vancouver Island and the eastern coastal region are quite remarkable. The most obvious example is the total annual precipitation on the coasts and its impact on seasonal river flows.

Annual rainfall on the west coast is, on average, three to four times a comparable location on the east coast, based on latitude and elevation.

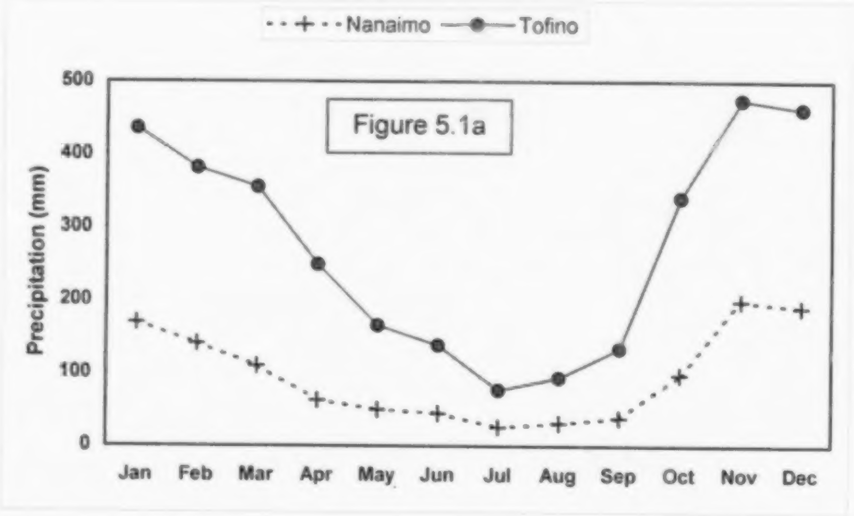


Figure 5.1a *compares the total monthly precipitation for Tofino on the west coast to Nanaimo on the east coast, both recording stations are essentially the same latitude and elevation.*

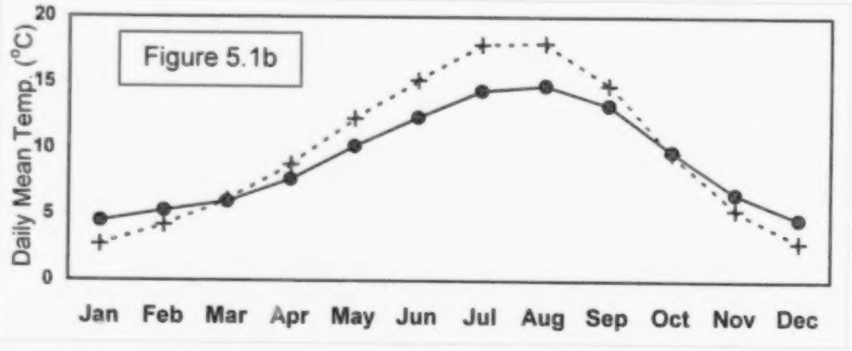
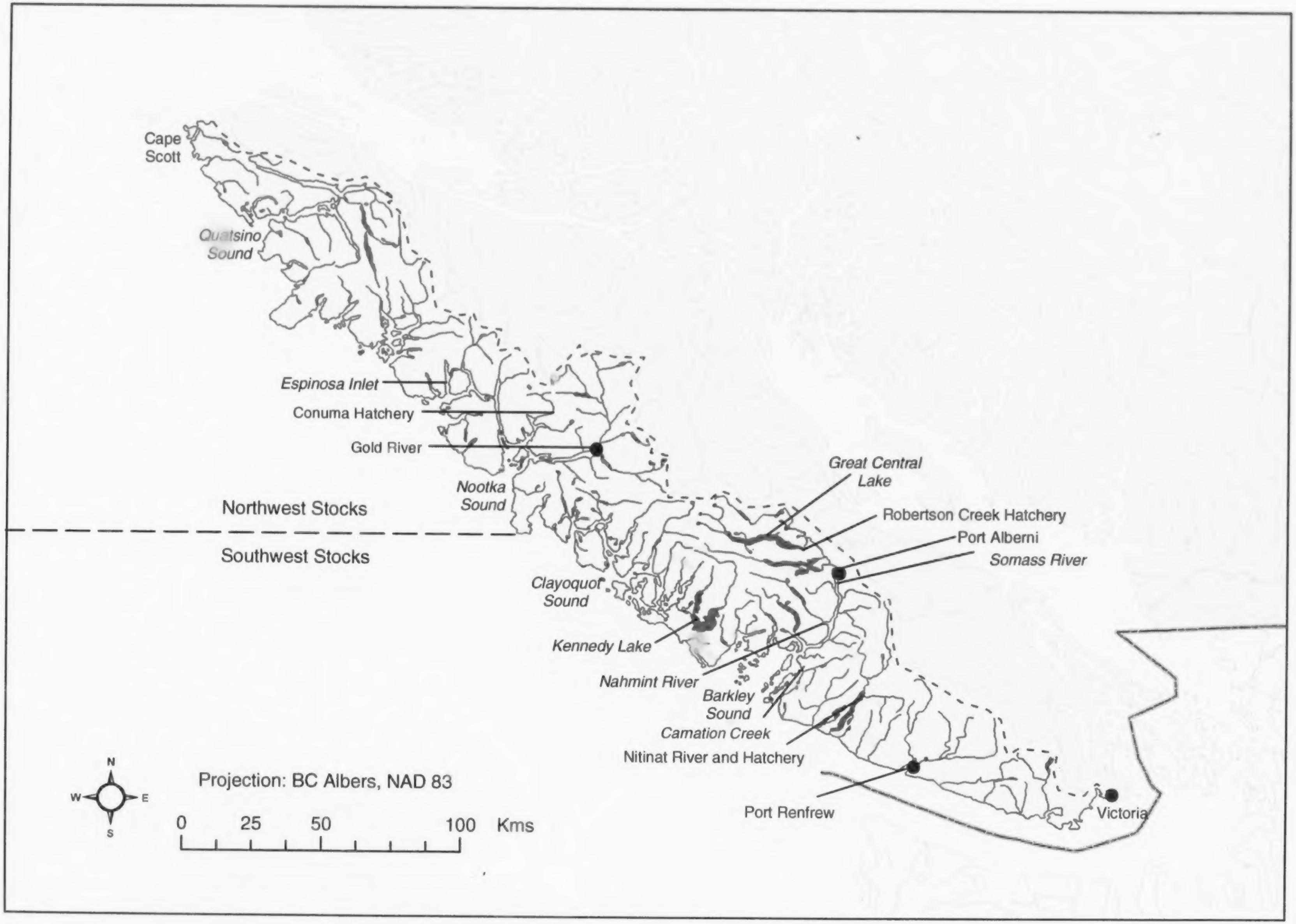


Figure 5.1b *presents the average daily temperatures by month. While the temperatures are moderated on the west coast the most notable difference is clearly in the seasonal rainfall levels on the west coast.*

These data are from Environment Canada for the most recent 30-year average, 1971-2000. More extreme examples may be found, but this comparison serves to demonstrate the differences in climate and the expected effects on river flows. When this volume of precipitation (about 99% in rainfall) is combined with the steep systems and the extent of habitat changes in many areas, the environment alone can be a challenge to the salmon

Map 5: West Coast Vancouver Region



along the West Coast of Vancouver Island. These figures show the "average" conditions, but extreme events are also more frequent on the West Coast than the east.

5.1 WCVI Sockeye

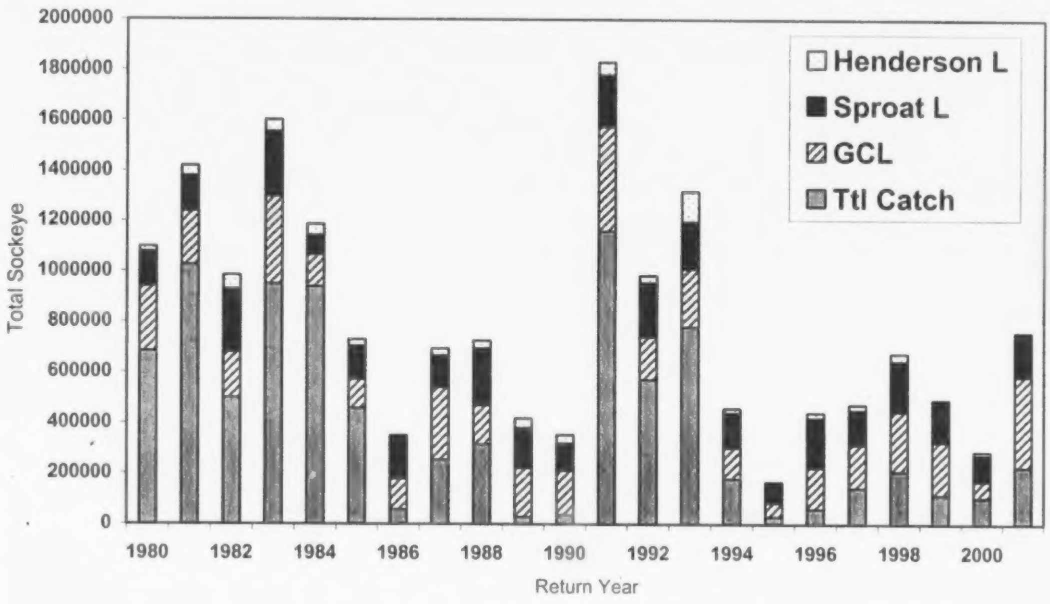
The situation for sockeye salmon along the West Coast is again different from the Fraser basin and the Strait of Georgia region. Sockeye are produced in many lake systems, but are also common in rivers without lakes. Depending on how spawning locations are aggregated or split, the Department's escapement records would indicate that sockeye utilize about 75 streams and lakes along the WCVI, but the "typical" sockeye system with a rearing lake would account for less than one half of this total. Many of these latter systems are located in the central portion of the WCVI north of Clayoquot Sound. The most prominent sockeye stocks along the WCVI are clearly in Barkley Sound and include Henderson, Sproat, and Great Central lakes.

Hyatt and Steer (1987) provide an interesting history of the use and development of the stocks in Barkley Sound over the past century. The Henderson Lake (also call the Anderson Lake Hatchery) hatchery, one of Canada's first sockeye facilities, operated from 1910 to 1935. The hatchery initially produced fish to supplement natural production from Henderson Lake, but between 1922 and 1933 also transferred eggs to Sproat and Great Central lakes until all Canadian sockeye hatcheries were closed in the mid-1930s. Hyatt and Steer document other developments that assisted sockeye production (dams for water control, fishways in the Stamp and Sproat rivers), but likely the most famous sockeye development initiative was the lake enrichment experiment undertaken by the Fisheries Research Board of Canada. The experiment built on an apparent relationship between numbers of adult salmon returns and subsequent productivity in freshwater lakes (see Stockner 1987). If adult returns were reduced, nutrients entering the lake could be reduced and subsequently limit the production of "food" for juvenile sockeye. If so, a "negative feedback" could become a major limitation to sustaining sockeye production and fisheries. As fisheries reduce the number of adults returning, the growth and survival of juvenile sockeye could be reduced and result in the loss of adults for the future fisheries or spawning populations. Therefore researchers asked, could nutrients simply be added to the lake to compensate for reduced nutrients from the adults?

The first whole lake experiments to test this were conducted in Sproat and Great Central lakes beginning in 1969, and the initial treatments were applied to Great Central Lake from 1970-1973. The results of the study were remarkable. LeBrasseur et al. (1978) reported that summer primary production increased five-fold, zooplankton production increased nine-fold, egg to juvenile sockeye production increased 2.6 times, and adult production increased from less than 50,000 spawners in the spawning years to over 360,000 in the return years. On this basis, the Lake Enrichment Program of the Salmonid Enhancement Program was developed and applied to many other BC lakes.

As Hyatt and Steer describe, the enrichment result was only the first aspect of building sockeye production in these lakes. The survival and growth of large numbers of juveniles demonstrated that Sproat and Great Central lakes were capable of producing many more sockeye. To achieve this, fishery managers needed to increase the numbers of sockeye reaching the spawning grounds. Consequently, the desired number of spawners (i.e., the escapement goals) for these stocks was greatly increased to over 100,000 sockeye per lake. Recent production from these lakes has varied with changes in the marine environment (Figure 5.2) but has continued to be much greater than before 1970. Unfortunately, the recent escapements for Henderson Lake have declined to only a few thousand spawners in 1999 and 2001.

Figure 5.2 *Total production (cumulative number of sockeye) from Barkley Sound sockeye stocks. The estimated spawning escapement for each stock is accumulated with the total catch from these stocks. GCL = Great Central Lake.*



Following the March 2002 meetings of the Salmon Sub-committee of PSARC, Fisheries & Oceans Canada initiated a review of the status of Henderson Lake stock, its escapement goal, and how to protect the sockeye. Returns to Barkley Sound during the summer of 2002 have been strong, but the escapement achieved in Henderson Lake is not currently known. This stock is a significant concern to the Council, and the Council will continue to monitor the stock.

While Barkley Sound is the centre for sockeye production along the WCVI, there are many other smaller populations that follow the typical sockeye life history (i.e., lake rearing for a year before emigrating to the ocean). Unfortunately, few of these populations are monitored as well as the Barkley Sound stocks and many of them are much smaller in abundance now than they were in the 1950s and 1960s. Table 5.1 summarizes these smaller sockeye systems along WCVI that have accessible rearing lakes and comments on their current size and frequency of escapement surveys. Since there has not been sampling in each lake population the Council cannot definitively state that each population is genetically different or even that each lake is used for rearing. The evidence from many other sockeye studies would suggest that each of these small populations would differ and add to the diversity of sockeye along WCVI.

***Table 5.1**. Sockeye salmon systems along WCVI that have access to rearing lakes. Watershed codes from BC Provincial Fisheries Inventory system.*

Spawning Stream and Lake	Location & (Watershed code)	Assessment and population size	Frequency of Assessments
Cheewhat lake	Outer southwest Vancouver Is. (930-070100)	Returns of 2,000 to 5,000 during late 1980s but only recent escapement value was 1,000 in 2000	There is dubious value to the escapement data before the mid-1980s, and only one survey conducted since termination of the Lake Enrichment program surveys.
Hobiton Lake	Tributary to Nimpkish Lake (930-071700-20600)	Generally several thousand spawners, present production greater than historical but enumerations have been improved.	Previously a Lake Enrichment study site. Fence built for enumerations now managed by local Band.
Kennedy Lake & river, Clayoquot River, Cold Creek, Muriel Lake and creek (off Clayoquot Arm of lake)	Clayoquot Sound (930-306400)	Average escapements to total system recorded at 50,000 during 1950s, recently recovered to 30 to 40,000 per year. Very little directed fishing pressures.	Annual surveys required at several sites in this lake system but methods have changed over time period. Evidence of abundance shift from Clayoquot Arm beach spawners to Kennedy River. Muriel Lake is considered a distinct population.
Hesquiat Lake and River	North of Clayoquot Sound (930-461400)	Small population with limited escapement records. First recorded escapements in 1968 and has varied from 18 to 850 spawners until 1982.	Escapement record very limited. No sockeye recorded since 1982 and most records are None observed or Not Inspected.
Megin Lake and River	Clayoquot Sound (930-413500)	Relatively small population with several hundred to 2,000 spawners on average since 1953. No long-term trend is evident in escapement values.	Records of spawners provided consistently since 1953 and the watershed is virtually undisturbed. Visual enumerations limited in accuracy by "Tea" coloured water.
Muchalat Lake & river, plus Oktwanch River	Gold River in Nootka Sound (930-511600-42100)	Moderate sized sockeye populations with reported escapements averaging about 10,000 sockeye from 1970s through to mid-1990s.	Escapement records since the mid-1990s very limited and escapement recorded for 2001 very poor, only about 600 sockeye reported.
Zeballos River and Lake	Upper Espinosa Inlet (930-582200)	Infrequent records of sockeye before the late 1970s, numbers peaked in mid-1990s (several thousand) but escapement in 2001 only recorded at 500 sockeye.	Infrequent records before mid-1970s but consistent records through the 1990s.
Park River and Lake	Lower Espinosa Inlet (930-615900)	Outer coast lake that previous to 1985 had consistent records of several hundred spawners and peaked in 1985 at 4,000.	Consistency of surveys is unknown but after 1985 escapement surveys are infrequent and spawners only recorded in 3 years (20 to 100 spawners).

Spawning Stream and Lake	Location & (Watershed code)	Assessment and population size	Frequency of Assessments
Owossitsa Creek and Lake	Lower Espinosa Inlet (930-483000-57000)	Outer coastal lake, similar enumeration history to Park Lake except last significant number of spawners recorded in 1980 (2,000 sockeye).	Consistency of surveys is unknown but after 1985 escapement surveys are infrequent and spawners only recorded in 1 year (125 spawners).
Jansen Lake and River	Kyuquot Inlet (930-692100)	Coastal lake with similar enumeration history to Park and Owossitsa lakes except that historical escapement estimates indicate the stock was at least twice the size of those others.	Last year of escapement record was also in 1985 and escapement surveys are infrequent after that. Only one year of sockeye escapement recorded (50 sockeye in 1992) most other years were Not Inspected.
Power Lake and River	Kyuguot Inlet (930-732300)	Between 1953-1968 the escapement records indicated a moderate sized stock of 1,500 to 3,500 sockeye. However, after 1968 the stock is reported to be much smaller and more variable.	Most years after 1968 are not inspected and 10 of the past 12 years were not inspected or reported. Last significant escapement recorded was 1,000 sockeye in 1991.
Canoe Creek and Lake	Brook's Peninsula (930-780600)	A very small population on the north shore of Brooks but no record of sockeye spawners since 1963.	Records indicate that the stock has essentially not been monitored since 1970.
Mahatta Creek and O'Connell Lake	Quatsino Sound (930-823900)	Early records indicate a moderate sized stock with escapement about 4,000 during the 1950s. Stock has declined to a few hundred in the 1990s. No record for 2001.	While substantial decline is indicated in the escapement record, the comparability of the surveys is unknown. It is likely though that this degree of reduction indicates are real decline.
Marble River and lakes	Quatsino Sound (930-865200)	While the lake system is large, there is no evidence that this system supported a large sockeye population. Since 1953 records indicate only a few hundred sockeye on average.	Surveys less frequent since 1980s and escapement estimates smaller. Ability to observe a decline from a small population in a large system is very doubtful. Accuracy of the decline is unknown.
Fisherman River and William and Brink lakes	Cape Scott (930-992000)	Early records indicate a moderate sized stock with escapement of 2-3,000 during the 1950s. No records of spawners after 1963.	Every year since 1970 has been Not Inspected or Unknown. No information on current stock.

A few of these systems have strong annual assessment programs, such as in Hobiton and Kennedy, but for most of them the current annual assessments are inadequate and infrequent. As was the Strait of Georgia, these assessment issues are a serious limitation to the Council's ability to comment on the status of the sockeye populations and how they have changed over the years.

The above discussions account only for about 30 of the WCVI sockeye populations. That leaves up to 45 other systems with sockeye that do not follow the typical lake-rearing life history. Sockeye salmon are known to rear in larger rivers, but the frequency of rearing in small to moderate sized streams along the WCVI is unknown elsewhere in southern BC. One immediate and alternative explanation could be that these sockeye are strays from the other populations. In areas such as Barkley Sound, where very large populations have developed, it is possible that strays would account for the small numbers of sockeye observed in the Sarita, Nahmint, Franklin, and Effingham rivers. But it is unlikely to be an adequate explanation for how common sockeye are in many other inlets. For example, in Nootka Sound sockeye salmon are annually recorded in essentially all of the salmon systems in the Sound, but there is only one notable lake-rearing population in Muchalat Lake, Gold River.

In 1997, large numbers of sockeye were observed in many streams around the Strait of Georgia. Scientists at the Pacific Biological Station hypothesized that these sockeye resulted from an unusual straying event from the Fraser River. Samples of sockeye were collected from the Strait and along WCVI. Results supported their hypothesis for the Strait of Georgia samples, but the WCVI samples were very unlikely to have been from the Fraser. Many of the samples had characteristics that had not been observed in Fraser River sockeye. Dr. Chris Wood of the Science Branch of Fisheries & Oceans Canada has suggested that these WCVI sockeye may be a “creek-type” sockeye that may actually differ in life history from the lake-rearing types. Dr. Wood’s hypothesis remains to be fully examined but it is consistent with the widespread nature of these fish, their variability in production (between years within a system), and differences reported in the above study. Whatever their source, the 1990s were a period of good production from these other sockeye systems, or, survey teams are becoming more adept at identifying and recording these sockeye.

The West Coast of Vancouver Island has a far more interesting history and diversity in sockeye salmon than it is commonly acknowledged. However, with only a couple of exceptions now, the ability to truly monitor and assess the status of these stocks is very limited. In the systems that are being managed annually (Sproat, Great Central, Hobiton, Kennedy), sockeye production has generally been increased. But, for many of the small lake systems, their abundance is depressed from past years. The Council’s confidence in the value of these assessments is limited by the infrequent monitoring of most of these populations.

The diversity of sockeye salmon in a highly dynamic environmental region is an interesting ecological question to the Council. The possibility of multiple life history strategies in these sockeye merits further investigation.

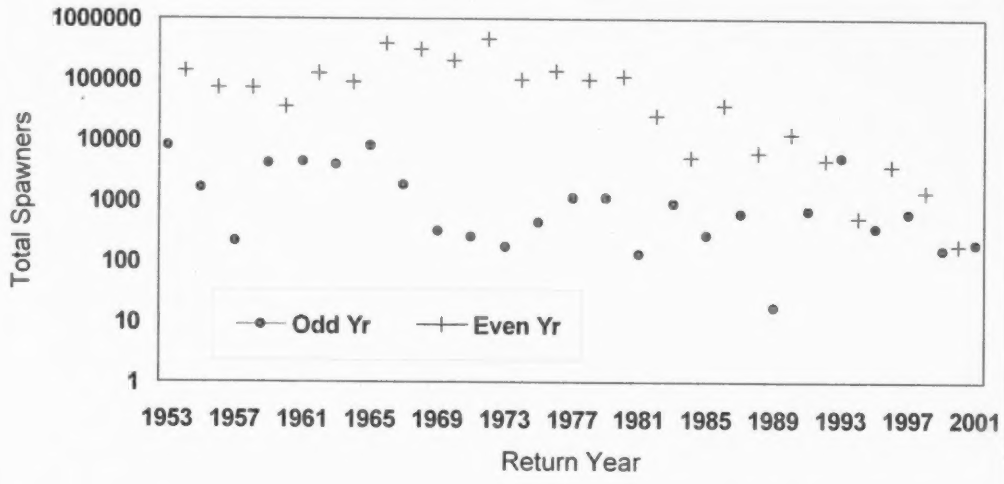
5.2 WCVI Pink

The West Coast of Vancouver Island is not a major centre of pink salmon production, and escapements are largest in the even-year line. Of the 272 streams with salmon escapements recorded since 1953 along the WCVI, odd-year pink salmon have been reported in 85 streams and the even-year lines were in 119 streams. Their spawning populations sizes are, however, much smaller than in the other regions that have been discussed and have shown major declines in spawners during the 1980s and 1990s (Table 5.2, Figure 5.3).

***Table 5.2** Summary of the reported spawning escapements of Pink salmon along the WCVI (summation of decade averages by stream) and the number of streams recorded with Pink salmon spawning.*

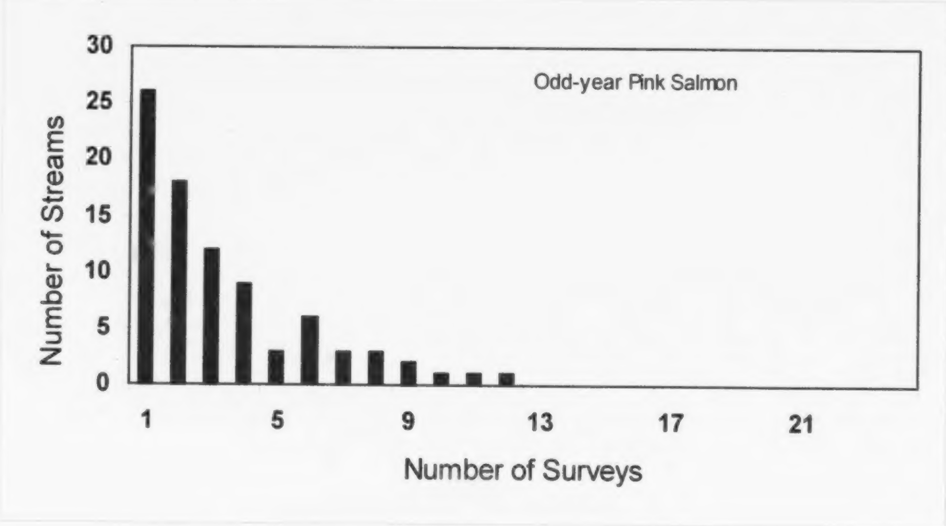
Category	**1953-60**	**1961-70**	**1971-80**	**1981-90**	**1991-00**
Total of all Odd-Year Spawners	9,100	9,250	2,100	1,350	2,100
Number of streams	16	48	35	33	63
Total of all Even-Year Spawners	102,000	239,000	212,000	19,800	4,700
Number of streams	80	90	84	24	36

***Figure 5.3**. Total spawning escapement of Pink salmon along WCVI as reported in spawning escapement records, 1953-2001 (2000 and 2001 data are incomplete by stream)by line.*



Records of pink salmon in odd numbered years (odd-year line) are difficult to assess since the occurrences of spawners are rare events. Only 14 streams had at least one decade average that exceeded 100 pink spawners, an extremely small population. Their rarity also limits the number of escapement surveys. Since 1953, there have been 24 years of potential surveys (per line) and 85 streams that have been recorded to support pink salmon. A plot of these possible surveys indicates that 75% of these streams have less than one escapement record for every five return years (Figure 5.4).

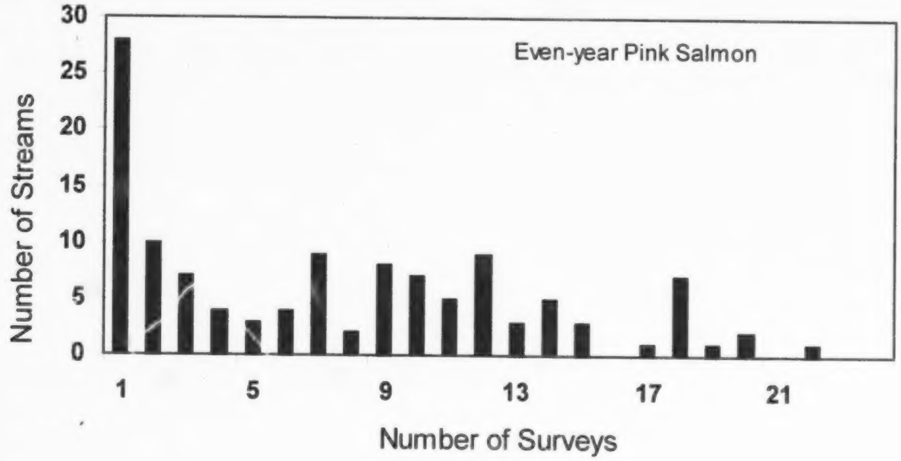
***Figure 5.4**. Frequency of escapement recordings by streams that have been observed to support pink salmon along the WCVI during odd numbered years. The total number of streams in this figure is 85.*



The odd-year pink salmon that have been recorded are mostly distributed in the northern half of the Island, but there seems to be little that can be concluded about the status of these populations. Of the 14 populations identified above, the average size of the populations declined significantly between decades in nine, showed no trend in four, and increased significantly in only one population. Given the frequency of inspection and small numbers of pinks being assessed, any conclusion on status would be of dubious value. If any conclusion is merited, it would be to recognize the need be for a more rigorous assessment program of odd-year pink salmon in a few streams along the WCVI. But, as Fisheries & Oceans Canada has apparently decided, there is little merit in extensive surveys trying to assessment such small pink salmon populations (although it is notable that the number of streams surveyed actually increased during the 1990s).

The even-year line is more abundant, and surveys have been conducted on a more consistent basis, but there has been a substantial decrease in the number of streams surveyed in the past two decades (Table 5.2). From 1953 through the 1970s, the number of steams surveyed and the average size of the estimated escapements had been quite stable (approx. 2,500 pinks/stream and 2.7 to 3.2 surveys per steam in each decade). However, in the 1980s, the number of streams surveyed was substantially reduced, frequency of surveys per stream maintained at 2.8 surveys per stream. During the 1990s, the number of inspected streams increased slightly, and the frequency of survey decreased to compensate (36 streams surveyed at an average frequency of 1.8 inspects in the decade). Overall, however, the survey coverage of even-year pink salmon was substantially better than for the odd-year pinks.

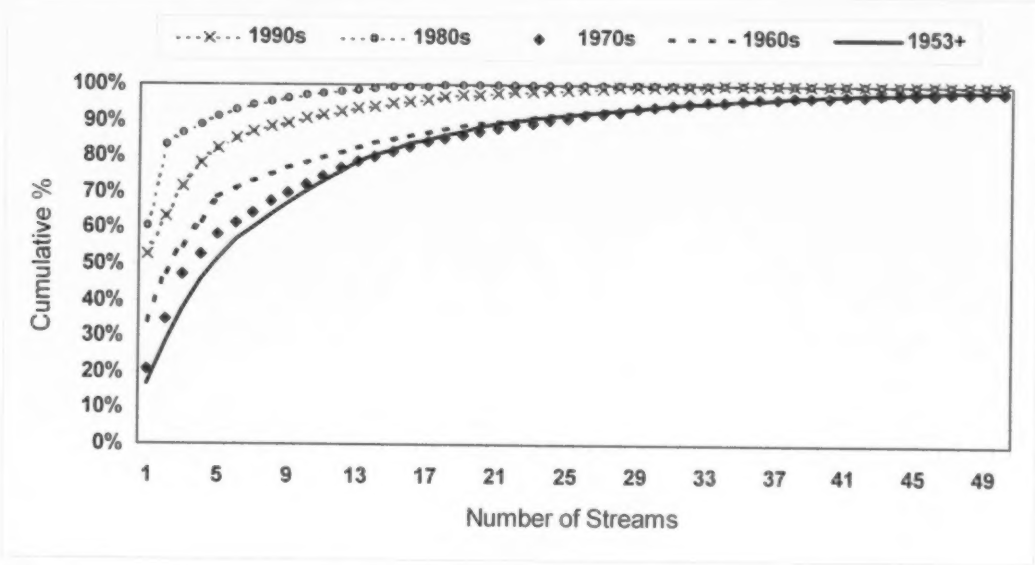
***Figure 5.5**. Frequency of escapement recordings by streams that have been observed to support pink salmon along the WCVI during even numbered years. The total number of streams in this figure is 119.*



For the even-year line of WCVI pink salmon, 27% of the stream populations have been surveyed half of the time (i.e., a stream is monitored in 1 of every 2 returns years), and 50% of the populations are surveyed in one of every three return years. While the accuracy of these surveys is unknown, this sampling intensity should be adequate to detect a trend in the abundance of spawners (catch from each population is unknown). If so, this leads to concern for the recent escapements since returns in the 1980s and 1990s have declined by over 80% and 95% respectively, compared to the previous three decades.

With the decline in total numbers of spawners during the 1980s and 1990s, there has also been a reduction in the number of streams surveyed. The distribution of spawners between populations varied a little between the 1950s and the 1970s, but the overall pattern showed only marginal change. However, in the last two decades, there was a noticeable concentration of spawners in fewer streams, according to the escapement records (Figure 5.6). There are currently fewer streams being enumerated and the population sizes are much reduced from the earlier decades.

***Figure 5.6**. Cumulative total production expressed as % of the total production per stream for even-year pink salmon along the WCVI, one curve for each decade in the escapement records*



The shift in curves from the 1950s to 1990s indicates that very few streams now contribute to the total spawning populations. For example, during the 1950s, about fifteen streams provided 80% of the total spawning populations. But in the 1990s, only two streams account for 80% of the recorded spawning of pink salmon during the even numbered years. Given this change in spawner distribution, it may be useful to identify the populations that have been the main contributors to the spawning population (Table 5.3). The stocks considered "major" were determined by ranking every population (stream) according to their average population size per decade and identifying the streams that most consistently were ranked as the 'top ten' populations. The absence of 'top ten' values in some decades indicates how variable the production could be between streams and years, but some systems show a consistent importance to production. It is notable in the table that seven of the populations listed in the 1990s column averaged fewer than 100 spawners, a very small pink salmon population. The other streams in the "top ten" for the 1990s were: Coleman Creek, Washlawlis Creek, Goodspeed River, Warn Bay Creek, and the Moyeha River (each of these had average escapements of less than a few hundred spawners).

Unfortunately, the trend of reduced population size seems to have been continued in the 2001 surveys. Only 188 Pink salmon were reported in 21 WCVI streams. This information should be considered preliminary because the records are incomplete.

Pink salmon along the WCVI is not a major salmon resource in terms of production, but there is a wide diversity of populations and a limited assessment program. Given how small the even-year populations have been and the recent decline in abundance of the odd-year pink salmons, there is a need for a more careful assessment of these populations.

Table 5.3. Ranked value for the most significant stocks of Even-year Pink salmon on WCVI. Stocks presented are the top ranked stocks (largest) over the period 1953-2000 based on size of their average spawning escapement by decade (first period only includes 1953-1960), each stock was ranked within each decade. Asterisks (*) note stocks that may be ranked but have dropped to average escapement values of ≤100 spawners. NR indicates no records for the stream in a decade.

Stream Name, location	1953-60	1961-70	1971-80	1981-90	1991-00
Burman River, Nootka Sound	4	1	1	2	26*
Waukwaas Creek, Quatsino Sd.	3	4	3	1	1
Kauwinch River, Kyuquot Sound	10	2	4	NR	24*
Koprino River, Quatsino Sound	1	5	15	13*	10*
Kaouk River, Kyuquot Sound	14	6	2	3	28*
Kwatleo River, Quatsino Sound	2	3	20	6	6
East Creek, north Brook's Peninsula, Brook's Bay	9	19	5	4	4
Leiner River, Nootka Sound	20	7	8	14*	11*
Zeballos River, Espinosa Inlet	34	13	7	10	13*
Little Zeballos R. Espinosa Inlet	39	8	10	NR	35*
Sample size per decade (total # of streams ranked)	80	90	84	24	36

5.3 WCVI Chum

Unlike the pink salmon, the WCVI chum are widely distributed and their production has increased over time, although a significant component of this increase is due to hatchery production. WCVI chum salmon have been reported in 241 of the 272 salmon streams and annual escapement surveys have consistently occurred (Table 5.4, Figure 5.7).

Table 5.4. Summary of total spawning escapement, number of streams surveyed, and average frequency of surveys by stream for WCVI chum salmon.

Information category	1953-60	1961-70	1971-80	1981-90	1991-00
Cumulative spawning escapement reported	485,250	357,100	484,900	482,800	748,300
Number of streams surveyed	184	189	198	194	211
Frequency of surveys in decade (ave. per stream)	87.5%	86%	77%	61%	54%

Table 5.3 *Ranked value for the most significant stocks of Even-year Pink salmon on WCVI. Stocks presented are the top ranked stocks (largest) over the period 1953-2000 based on size of their average spawning escapement by decade (first period only includes 1953-1960), each stock was ranked within each decade. Asterisks (*) note stocks that may be ranked but have dropped to average escapement values of ≤100 spawners. NR indicates no records for the stream in a decade.*

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Waukwaas Creek, Quatsino Sd.	3	4	3	1	1
Kauwinch River, Kyuquot Sound	10	2	4	NR	24*
Koprino River, Quatsino Sound	1	5	15	13*	10*
Kaouk River, Kyuquot Sound	14	6	2	3	28*
Kwatleo River, Quatsino Sound	2	3	20	6	6
East Creek, north Brook's Peninsula, Brook's Bay	9	19	5	4	4
Leiner River, Nootka Sound	20	7	8	14*	11*
Zeballos River, Espinosa Inlet	34	13	7	10	13*
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Sample size per decade (total # of streams ranked)	80	90	84	24	36

5.3 WCVI Chum

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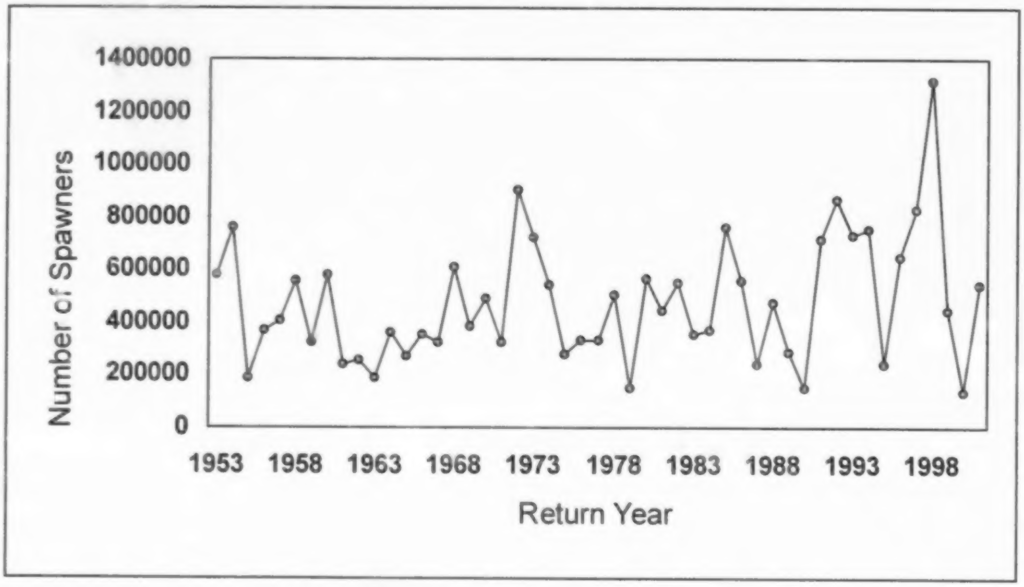
Table 5.4 *Summary of total spawning escapement, number of streams surveyed, and average frequency of surveys by stream for WCVI chum salmon.*

Information category	1953-60	1961-70	1971-80	1981-90	1991-00
Cumulative spawning escapement reported	485,250	357,100	484,900	482,800	748,300
Number of streams surveyed	184	189	198	194	211
Frequency of surveys in decade (ave. per stream)	87.5%	86%	77%	61%	54%

***Figure 5.7**. Total numbers of chum salmon spawning in WCVI streams, 1953-2001.*



There is no current stock assessment for WCVI chum salmon, and the reports on catch maintained by the Pacific Salmon Commission are not current. Catch data is maintained, but to assign the catch to stock requires various models or stock identification tools, including data on the US chum stocks caught in some WCVI chum fisheries.

As noted above, these surveys have been consistent and indicate an expanding resource, but some of this expansion must be attributed to the Salmon Enhancement Program. Chum salmon production has been a significant component of the WCVI enhancement activities that have been successful in producing chum salmon. The releases of fed-fry have been substantial from major hatcheries (Nitinat and Conuma) and smaller facilities (Figure 5.8). Releases are currently about 10 million fry per year in the northern-half of the island and about 20 million per year in the south. Major areas of return are Nootka Sound (Conuma Hatchery) and Nitinat Lake and coastal areas (Nitinat Hatchery).

The importance of enhanced chum returns in the recent decades is a major change in production that one might expect to see in the escapement data. If so, the plots of cumulative returns by stream that are used in previous sections to examine changes in diversity, may be expected to show greater contributions from a few large enhanced populations. In fact, the change in diversity is not as notable as might be expected, but indicates a trend from the 1950s through the 1990s. Since the 1950s, fewer populations are contributing a proportionately larger share of the total escapement, as shown by the curves shifting to the left (Figure 5.9).

***Figure 5.8**. Releases of chum salmon fry from all enhancement facilities along the West Coast of Vancouver Island. The stacked-bar graphs indicate the total releases by accumulating releases from NWVI (northwest VI, Statistical areas 25-27), and SWVI (southwest VI, statistical areas 20-23) by spawning year. Fry from a spawning year migrate to sea in the following spring.*

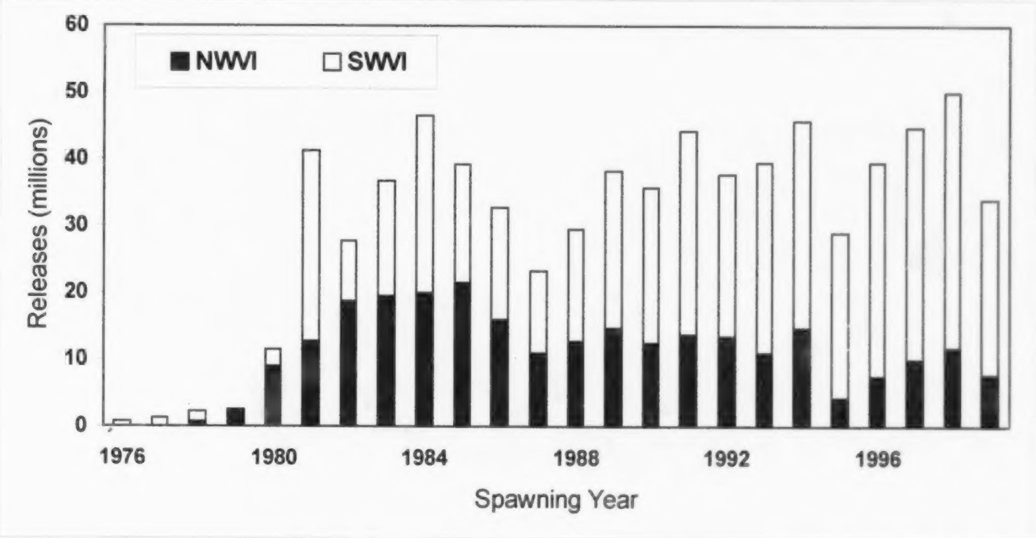
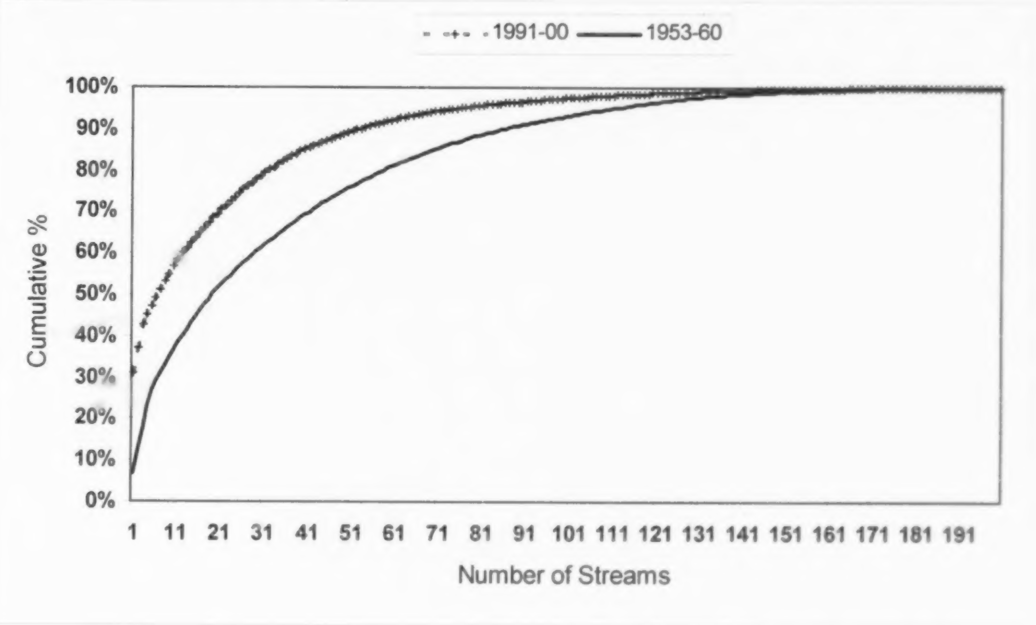
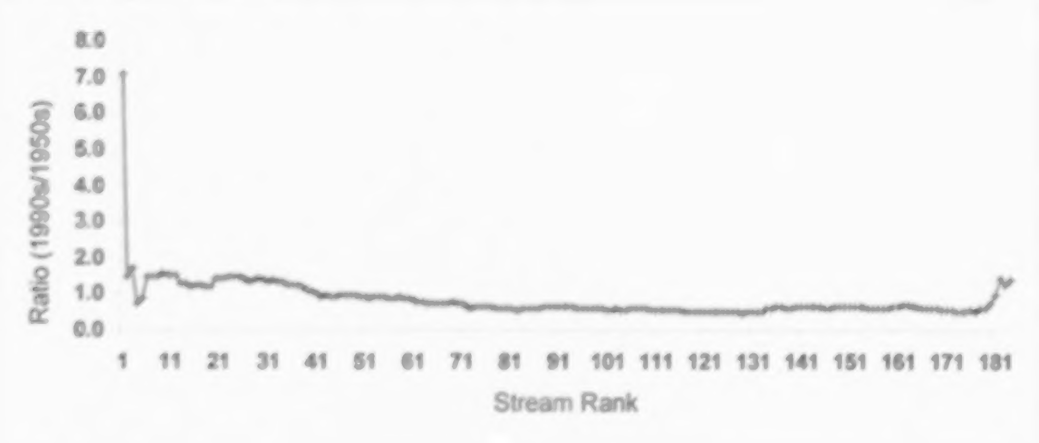


***Figure 5.9**. Cumulative total escapement expressed as percentage of production contributed by stream for each decade since 1953. Curves for each decade overlap so only the first and last decade are presented.*



Given the enormous numbers of chum fry released, why have the heavily enhanced populations not over-shadowed the natural populations? The enhanced production returning to some WCVI rivers has certainly contributed to the shifting of the 1990s curve in Figure 5.9. These systems include the Nitinat River in particular and several rivers in Tlupana Inlet (Nootka Sound). However, these enhancement programs have also allowed fishery managers to direct harvesting onto the hatchery-produced stocks and minimize harvest of other stocks and inlets. By comparing the reported spawning escapements, it is apparent that about 40 of the largest populations are all larger in the 1990s than in the 1950s (Figure 5.10). These streams account for about 80% of the total spawning escapement in each decade, but account only for 25% of the chum streams along the WCVI. Over the five most recent decades, the escapement from these streams has been maintained and accounts for most of the trend in Figure 5.9. Of some concern, however, is the other 100 or so streams that are now smaller in chum production than during the 1950s. Overall, the decline could be considered modest considering the human development along the coast since 1953. One should also remember that if fisheries have been directed onto enhanced populations, then the escapements during the later 1980s and 1990s (and represented in these figures) would represent a larger portion of the total production (catch plus spawners) than would have occurred in earlier times.

***Figure 5.10**. Ratio of changes in spawning escapement levels by stream rank for WCVI chum salmon (e.g., size of the 10th ranked population in the 1990s divided by the 10th ranked population size in the 1950s).*



An examination of the populations with the largest escapement by decade also indicates that some have consistently been the largest while others have varied, as would be expected in highly volatile environments such as the WCVI streams (Table 5.5).

For example, comparing the streams ranked 1 to 7 during the 1950s with their rank in the later decades indicates that they have consistently been amongst the largest chum stocks, even before enhancement. From rank 8 onward (i.e., lower rank values) the consistency declines, although considering that there are potentially 241 streams to rank, their values also tend to remain in the upper values. That is not always the case, though, as Henderson Lake or Inner Basin River chums have shown. The influence of hatchery production is also evident, particularly in Nootka Sound. Conuma Hatchery in Nootka South has contributed to increased escapements in that area: Conuma, Deserted, Canton, Sucwoa, and Tlupana rivers.

The above presentation examines the long-term trends in WCVI chum salmon. With the reduced marine survivals noted for other species and regions, what is the situation in the past couple of years?

Chum spawning escapements indicate that production has been reduced in the past few years, although the records of escapement are incomplete for 1999 through 2001. No records for example, have been provided for Quatsino Sound. In past decades, chum escapements in Quatsino Sound accounted for 8.5% of the total WCVI chum escapement, so the missing data are unlikely to change the assessment that production has declined relative to pre-1999 levels.

***Table 5.5**. Ranked value for the most significant stocks of WCVI chum salmon. Stocks presented are the top ranked stocks (largest) over the period 1953-2000 based on size of their average spawning escapement by decade (first period only includes 1953-1960), each stock was ranked within each decade.*

Stream/Population	Stream rank in 1953-60	Stream rank in 1961-70	Stream rank in 1971-80	Stream rank in 1981-90	Stream rank in 1991-00
Nahmint River	1	3	4	4	3
Sarita River	2	1	2	3	4
Nitinat River	3	2	1	1	1
Toquart River	4	7	5	8	11
Tranquil Creek	5	22	32	45	44
Tahsis River	6	5	6	15	8
Tahsish River	7	11	10	7	15
Inner Basin River	8	4	21	30	46
Zeballos River	9	20	14	19	12
Henderson Lake	10	25	50	126	126
Atleo River	11	19	3	5	31
Conuma River	12	14	11	2	2
Burman River	15	10	23	38	16
Megin River	16	24	8	20	33
Malksope River	18	6	13	17	29
Tsowwin River	25	8	22	10	4
Deserted River	28	16	15	6	10
Park River	32	9	16	21	28
Canton River	45	65	56	23	9
Sucwoa River	53	23	20	12	7
Kaouk River	54	79	17	9	14
Cayeghle system	55	29	7	11	19
Leiner River	57	13	9	18	17
Tlupana River	121	54	37	14	6

The decade average for 1991 to 2000 used in the above tables included the years 1999 and 2000, so these changes are partially accounted for. However, if the 1990s average was only estimated for 1991-1998, the average would have increased by only about 1%. The values for 1999 to 2001 in Table 5.6 were increased by 8.5% to compensate for the data missing from Quatsino Sound (a maximum of 45 streams have been surveyed in that region).

The reduction in escapements is most notable from Nootka Sound and north. Many streams, including those associated with the Conuma Hatchery, showed a substantial reduction in spawners and many small to moderate-sized systems were not inspected. Reductions in the numbers of spawners also occurred in the southern portion of the coast, but changes in escapement were more mixed in the south.

Table 5.6. Summary of escapement values by years.

Years	Escapement Values for WCVI Chum
1991-98	763,000 (126 streams surveyed on average)
1999	484,000 (77 streams surveyed)
2000	144,000 (62 streams surveyed)
2001	590,000 (85 streams surveyed)

With increased spawners recorded in 2001, though, there is no apparent significant change in distribution over the coast. The most notable concern would be the absence of any data for Quatsino Sound chum salmon for the past three years, and an apparent reduction in the number of streams being surveyed through the 1990s.

> While there may be specific local populations that are of concern, possibly due to localized impacts, the general status of WCVI chum populations seems quite good when reviewed at this level.
>
> After many years of consistent survey coverage, any reduction in this activity will complicate future stock assessments. The Council is concerned that, that given the extent of enhancement and diversity evident in WCVI chum stocks, that there is no detailed assessment for this region or of the need for the current magnitude of hatchery chum production.

5.4 WCVI Coho

Coho are the most widely distributed salmon along the WCVI, having been reported in 700 streams and tributaries within 243 watersheds. Table 5.6 summarizes the coho escapement data, but the difficulty of monitoring this elusive species gives rise to questions about the accuracy of the values and consistency of the surveys since 1953.

As in the other regions, assessment and management of coho salmon is more reliant on detailed information on a few indicator stocks, than on the annual escapement surveys. The important issue is whether or not variations in the number of spawners result from changes in freshwater or ocean habitat conditions, or from exploitation rates in the large ocean mixed-stock fisheries. Escapement data by itself is inadequate to address this question. Tagging (coded-wire tagging of juvenile coho) of the indicator stocks is required to separate the effects of survival variation from changes in exploitation rates. Along the WCVI there is only one tagged indicator stock: the Robertson Creek Hatchery (RCH) in the Somass River, near Port Alberni. A natural coho population at Carnation Creek on the south shore of Barkley Sound, near Bamfield, also provides quantitative assessment data (counts of juveniles and adults through a fence), but tagging only began in 2001.

***Table 5.7**. Summary of total spawning escapement, number of streams surveyed, and average frequency of surveys by stream for WCVI coho salmon.*

Information category	1953-60	1961-70	1971-80	1981-90	1991-00
Cumulative spawning escapement reported	131,700	166,400	123,500	87,400	88,100
Number of streams surveyed	169	179	183	160	189
Frequency of surveys in decade (ave. per stream)	80%	74%	66%	43%	41%

Most coho assessments along the WCVI reply upon the long-term datasets for Robertson Creek Hatchery and Carnation Creek. Their history and importance to management of WCVI coho is well documented in a few recent reports available on the PSARC website (www.pac.dfo-mpo.gc.ca/sci/psarc/), see:

a. Stock Status Report D6-06 (2002).
b. Status in 1999 of Coho Stocks on the West Coast of Vancouver Island.
c. Forecast for southern BC coho salmon in 2002. PSARC Salmon Working Paper S2002-02

Coho salmon along the WCVI experienced a serious decline in marine survival during the early 1990s (Figure 5.11), but many of these populations seem to have recovered more quickly than the Fraser and Strait of Georgia stocks. The decline in marine survival was substantial, but the closures of WCVI salmon fisheries in 1998 enabled a strong pace of recovery. The coho salmon that were spawned in 1991, entered the ocean in spring 1993, and were caught in the 1994 fisheries experienced the worst survival rates ever recorded and were near-zero. However, exploitation rates on WCVI coho stocks were substantially reduced in 1998 (Figure5.12) and the extent of the reduction allowed a more rapid recovery of these coho since they were not been exploited in any other major ocean fishery.

***Figure 5.11**. Marine survival variation in Robetson Creek Hatchery coho and naturally produced coho from Carnation Creek. Survival rates arepresented by calendar or catch year (Age 3 adult coho) but can be related to their spawning yearby subtracting 3 from the calendar year.*

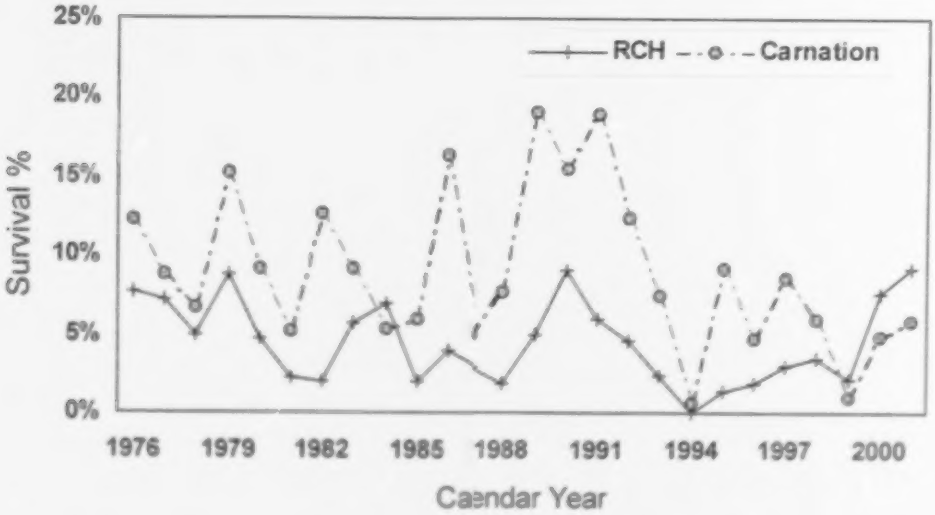
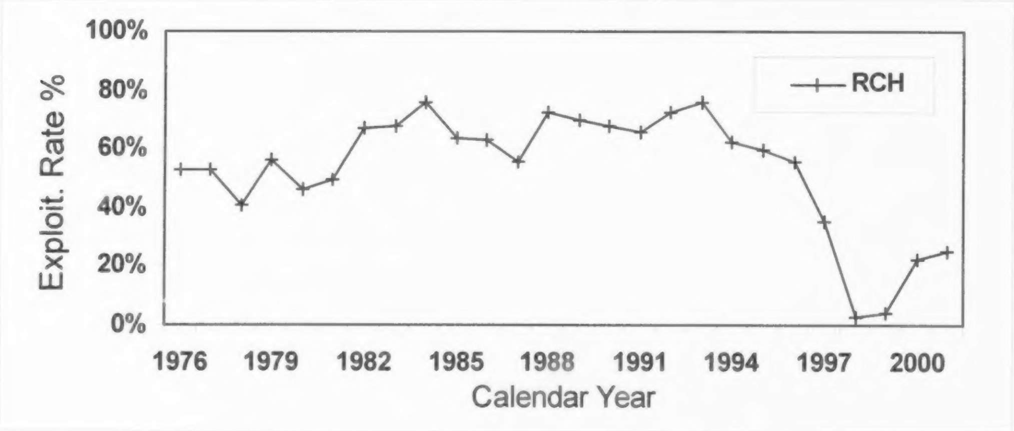


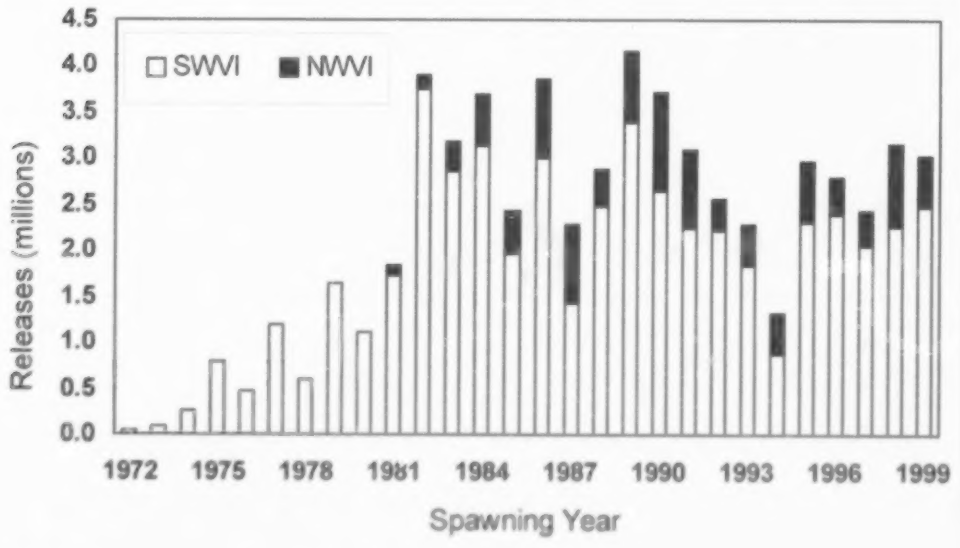
***Figure 5.12**. Total exploitation rates on Robertson Creek Hatchery coho salmon since 1973 spawning year.*



In 1994, the total number of coho salmon counted through the Stamp Falls fishway (coho returning to RCH) was less than 1,000, only one to two percent of past returns. However, as the spawning escapement data will show, the closure of fisheries in 1998 and reduction in exploitation rates annually to essentially zero during 1998-2000 provided a needed recovery opportunity for these stocks. The reduction in marine survival of the 1996 spawning year was not even detected in the escapement data.

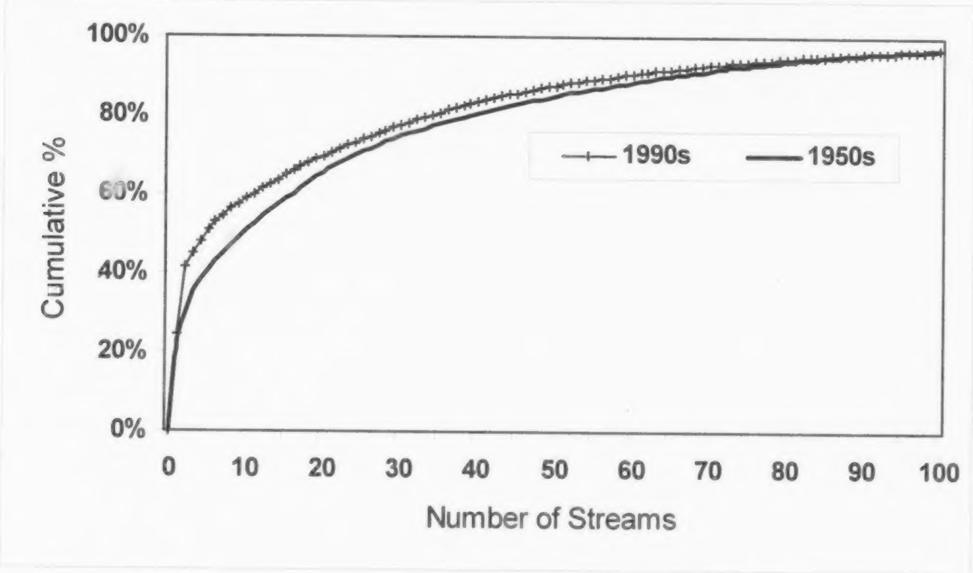
Two major issues complicate any use of the coho spawning escapement data: the uncertainty of the annual survey accuracy, and the increase in enhancement activities along the WCVI. The total release of coho salmon from enhancement programs (large hatcheries and smaller local programs) has been substantial, beginning with RCH releases in 1973 (Figure 5.13). Poor survival occurred during the spring/summer of 1993, and the brood stock available in 1994 was not adequate to replenish the stocks as evidenced by the decreased number of fish released in 1994 (Figure 5.13).

***Figure 5.13**. Total cumulative release of coho salmon from enhancement facilities along WCVI since 1972 spawning year. Bars present numbers released in the southern portion of the Island (SWVI, Clayoquot Sound south), and for Nootka Sound and north (NWVI).*



Many of the releases are in the larger river systems, and their dispersal to other smaller systems is not well monitored. The use of cumulative escapement plots (Figure 5.14) to compare the number of streams contributing to the total spawning escapement shows a surprising similarity between the 1950 and 1990 decades even in the face of these enhanced releases of coho salmon.

***Figure 5.14**. Cumulative total escapement for WCVI coho salmon expressed as % of total spawning escapement contributed per stream for the period 1953-60 and 1991-2000 (one curve for each decade). Only the top 100 streams are presented in this figure.*

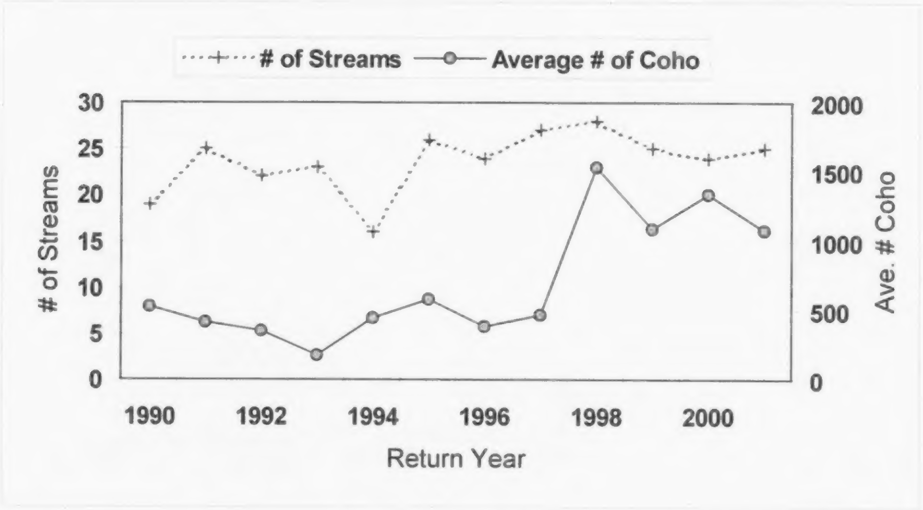


While there is some evidence of a few streams contributing relatively more (curve shifts to left), the difference is small, given all of the potential impacts since the 1950s.This result would suggest that, along the WCVI, there has been little change in the diversity of naturally spawning coho populations versus those of the 1950s.The question is whether this apparent condition is real or simply reflects how difficult it is to monitor coho salmon production.

This is a recurring theme in coho assessments that has been addressed during the current coho fishing closures. After the major decline in marine survival was observed, additional monitoring programs were implemented in a number of WCVI streams to estimate more quantitatively the spawning escapement of coho salmon (see Dobson et al. 2000. CSAS Res. Doc. 2000/160). More thorough surveys were reported in 58 streams and a subset of streams selected as an indicator of trends in the naturally spawning populations (Dodson et al. 2000).

To evaluate the current coho situation and depict the recovery of coho following these fishery closures, the Council summarized spawning escapements from 1990 to 2001 in 28 streams with consistent escapement records. The larger sample in Dodson et al. does not seem to have been maintained in the available escapement dataset. The streams used in this "index" of natural spawning are noted at the end of this section, but include streams from Juan de Fuca to Quatsino Sound at the northern extent of the Island. Even with these expanded surveys, there are years when escapements could not be estimated using the standards required for this subset of streams. The number of surveys conducted annually is noted in Figure 5.15 and the average escapement from the surveyed streams is presented.

***Figure 5.15**. Trend in the average number of coho estimated to have returned to a subset of natural production systems along WCVI since 1990. Average values are estimated for the number of streams surveyed in each year.*



The benefit of the fishery closures was observed immediately in the 1998 spawning escapement that doubled or tripled from previous years. It is also notable that the escapement in 1994 did not show the large decrease in spawners noted in the indicator stocks. However, by comparing escapements by geographic area and year, there is evidence that the decline in survival was greatest in the southern portion of the Island. The northern streams in this "index" group may have compensated for the southern decreases. It is also significant that the escapements in 2000 and 2001 did not show a large increase even though the exploitation rate in ocean fisheries continues to be low (estimated to be 5-15%) and survival rates have improved. This could again be associated with geographic differences in survivals since both estimates of marine survival are based on two indicator stocks in Barkley Sound in southwest Vancouver Island. This situation should continue to be monitored closely over the next few years.

List of spawning streams used in the escapement "index" Figure 5.15:
Gordon River, Klanawa River, Carnation Creek, Maggie River, Nahmint River, Sarita River, Thornton Creek, Toquart River, Bedwell River, Megin River, Moyeha River, Tranquil Creek, Burman River, Canton River, Leiner River, Sucwoa River, Tahsis River, Tlupana River, Tsowwin River, Zeballos River, Artlish River, Easy Creek, Kaouk River, Kashutl River, Kauwinch River, Tahsish River, Cayeghle Creek, Marble River.

The Council's observations concerning WCVI coho are similar those for the Fraser River and Strait of Georgia. The stocks have been recovering from substantial declines in marine survival, and the fishery closures facilitated the recovery. Those fishery management decisions were appropriate, as were the improved surveys in those natural stream systems. There is a continuing need to be precautionary in management and to monitor the recovery of these stocks.

The Council recommends establishment of an indicator stock in the northern half of the Island. Also, any indicator stock-monitoring program should estimate the incidence of hatchery-produced spawners in these "natural" systems.

5.5 WCVI Chinook

Chinook salmon have been recorded in 133 different systems since 1953, but the escapement records for this species may be the poorest in this region. Chinook utilize most of the moderate to large rivers along the WCVI and most spawning occurs before the end of October. However, the frequency of spawning records is fragmented. Since 1953, 55% of the streams with chinook have averaged only two escapement surveys in each decade, and 72% of the streams are reported fewer than five of every ten years. Ironically, this is one of the most important species/stock combinations along the Pacific coast and in recent years has determined the extent of ocean fisheries along the WCVI and in northern BC.

As adults, these chinook mostly return to WCVI in late August through September, except for Conuma and Burman stocks that return about one month earlier. All of the stocks are referred to as "far-north migrating" chinook. All of them migrate north through Alaskan waters and are extensively harvested in those fisheries. Upon their return migration, they are harvested in northern BC fisheries and then in the terminal areas (i.e., near shore and in the inlets) of WCVI.

The chinook salmon escapement data is summarized in Table 5.6, but the accuracy of the values and consistency of surveys since 1953 is highly uncertain. Compared to the other species along the WCVI, the numbers of streams surveyed are fewer and the populations smaller. Over time, though, the number of spawners has increased in the past two decades. This has a couple of contributing factors, including expansion of the hatchery programs, and reductions in the fishing mortality in ocean fisheries. In order to assess these populations, it must be determined whether changes in spawning escapements result from variation in survival or from reduction in exploitation of the adults. Both are frequently involved, further supporting the need for quantitative assessments using the indicator stocks and monitoring of the escapement trends in natural populations.

Table 5.8. *Summary of total spawning escapement, number of streams surveyed, and average frequency of surveys by stream for WCVI chinook salmon.*

Information category	1953-60	1961-70	1971-80	1981-90	1991-00
Cumulative spawning escapement reported	32,900	31,000	24,300	66,100	110,800
Number of streams surveyed	65	82	84	65	99
Frequency of surveys in decade (aver. per stream)	72.5%	64%	54%	50%	43%

The hatchery program for WCVI fall chinook is substantial (Figure 4.16) and includes the largest chinook hatchery in Canada at Robertson Creek Hatchery (RCH). RCH is the only quantitative indicator stock for this region and results are reported annually to PSARC (Riddell et al. 2001[12]). This document is updated annually to provide abundance forecasts and for pre-season fishery planning. The assessment has been required each year due to the extreme variation in marine survival observed for this stock. Since the 1973 spawning year, variation in the survival of fall chinook released from RCH has varied by almost 1,000 fold, from 0.01% to over 13% marine survival (Figure 5.17).

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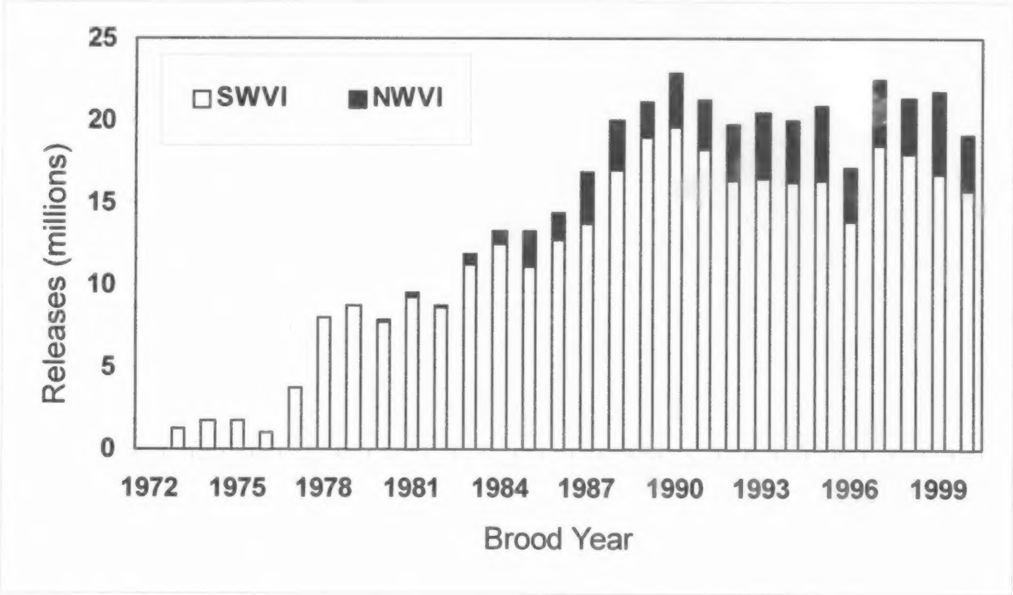
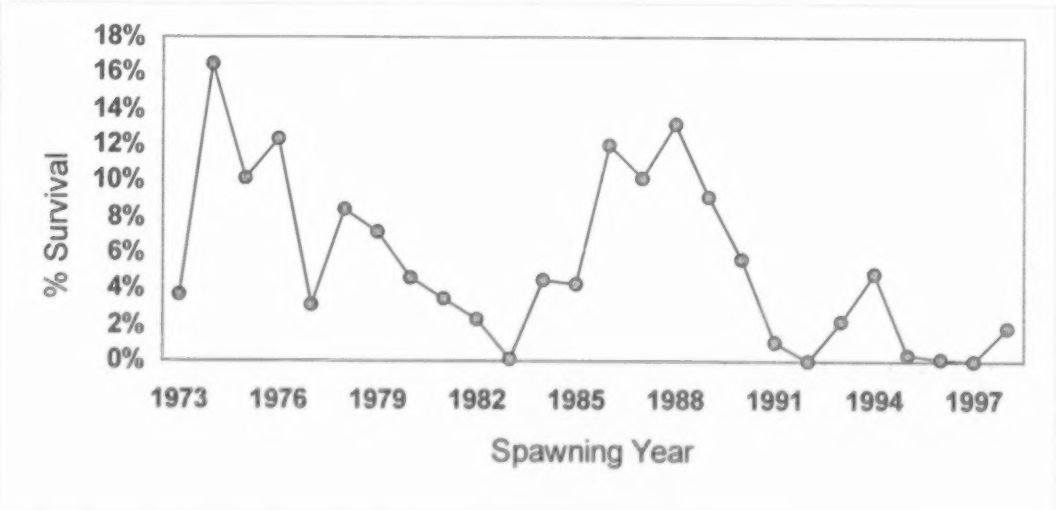
[12] www.dfo-mpo.gc.ca/csas/Csas/English/Research_Years/2001/2001_155e.htm

Figure 5.16. *Releases of fall chinook along WCVI since 1973 brood year. Fall chinook migrate to the ocean in the following spring/summer (Year of Ocean Entry), releases are presented by NWVI and SWVI as for chum and coho salmon. Major hatcheries in the SWVI include the San Juan, Nitinat, and Robertson Creek. In NWVI, Conuma Hatchery is the major facility.*



Conservation of WCVI chinook became a major issue in the 1990s due to the four very poor years of survival in Figure 4.17 (1993, 1996,1997, and 1998). The latter three years in a row is a particularly difficult problem due to the multiple age-classes in chinook salmon (adults return to spawn only once, but may return at ages 2-5). The effect of one poor year of survival is spread over a few years of adults returns, but a sequence of years of poor survival years could result in no spawners returning at all. For this reason, fisheries along WCVI and into northern BC have been closed, or substantially curtailed, several times since 1996.

Figure 5.17. *Annual variation in the marine survival of fall chinook salmon released from Robertson Creek Hatchery in WCVI.*



These restrictions have been taken based on the RCH indicator stock program, and monitoring of the spawning escapements to other systems has been undertaken. As noted above, though, the escapement monitoring of chinook salmon in this region has been limited. The stocks currently monitored consist of two aggregates of naturally-spawning populations, largely excluding the major hatchery systems that are tracked separately. In order to assess the Pacific Salmon Treaty in 1985, an aggregate referred to as the Pacific Salmon Commission Index was identified and based on an assessment that they were the most "consistently" monitored systems along the coast. These rivers included the Burman, Gold, Tahsis, Kaouk, Artlish, Tahsish, and Marble. Two concerns were identified for this aggregate: levels of enhancement varied between them and could be substantial as in the Marble; and, the rivers were all in the northern portion of WCVI (Nootka Sound and north). Following the major decline in spawners due to the 1993 El Nino event, a second aggregate of streams was identified and (like for WCVI coho) new and more rigorous escapement monitoring programs were implemented in those systems plus eleven others to supplement this information. The rivers included in the second aggregate were: San Juan, Sarita, Nahmint, Liener, Zeballos, Gordon, Toquart, Bedwell/Urus, Moyeha, Megin, and Colonial/Cayeagle. These two indices of escapement trends have essentially mirrored each other except in during 2001 when the PSC Index systems declined but the other index increased. The trend in these indices of escapements to the naturally spawning chinook systems is presented in Figure 4.18.

With the development of a major enhancement program and the growth of fishing on these stocks, one would expect the distribution of production between streams to have changed substantially since 1953. However, using the cumulative escapement plots to compare the number of streams contributing to the total spawning escapement shows a surprising similarity between the 1950 and 1990 decades after accounting for returns to just the three major enhanced systems: Somass, Nitinat, and Conuma rivers (Figure 5.19). If this figure was produced with the actual returns to the three enhanced systems then the curve is very steep on the left side, indicating a major change from the 1950s, but only attributed those three rivers.

Figure 5.18*. Time trend of spawning chinook salmon returning to the mostly natural populations included in the PSC Index and the combined index (PSC plus added 11 streams).*

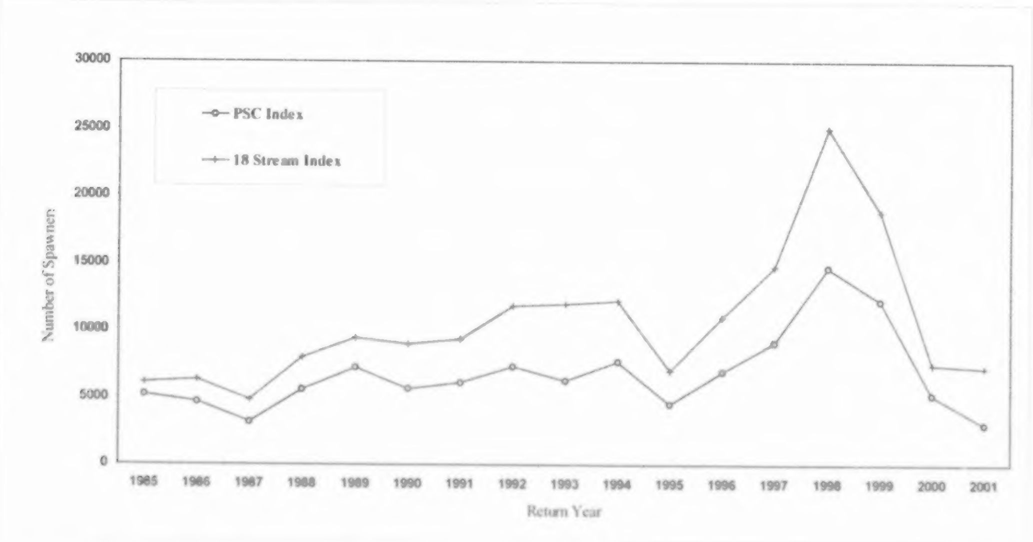
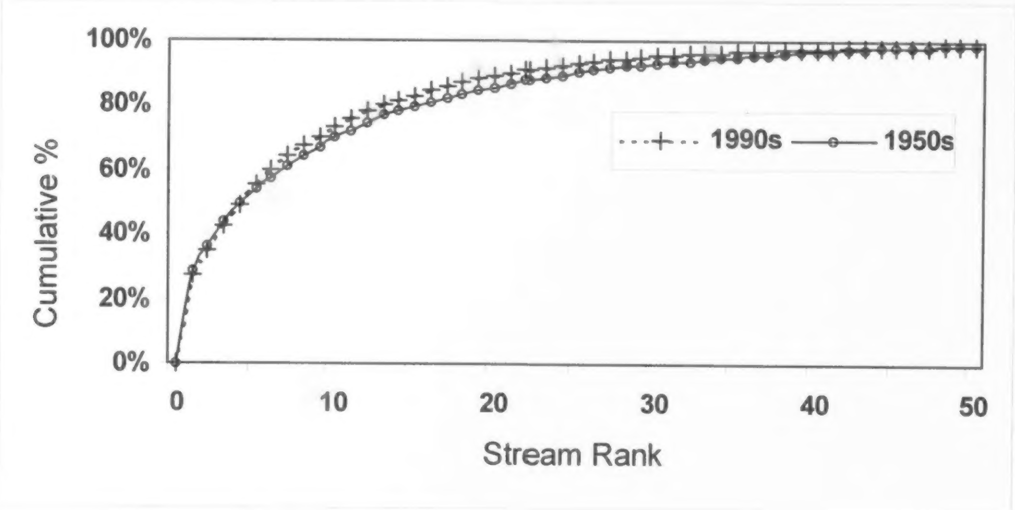


Figure 5.19. *Cumulative total escapement for WCVI chinook salmon expressed as % of total spawning escapement contributed per stream for the period 1953-60 and 1991-2000 (one curve for each decade). Only the top 50 streams are presented in this figure.*



Naturally-spawning chinook along the WCVI are depressed compared to the recovery evident in the mid-1990s, but they should benefit from improved marine survival in the most recent spawning years. Their current status is being maintained by restrictive fishing measures to compensate for a prolonged period of poor marine survival. Recent reductions in fishery exploitation rates should be continued until recovery in these natural stocks is evident. Continued monitoring of these natural systems is required in the short term to ensure adequate numbers of spawners.

The variability in marine survival and multiple ages of chinook spawners necessitates annual biological sampling of spawners for sex and age, and monitoring of the contribution of hatchery fish to natural spawning grounds.

Given the extremely variable marine survival in this region, the combined assessment of a tagged indicator stock and expanded monitoring of natural systems is an appropriate basis for assessment. As with WCVI coho salmon, however, the Council recommends a second tagged indicator stock in the northern portion of WCVI to supplement the data from the RCH indicator.

6. Approach to Issues and Challenges

Since the Pacific Fisheries Resource Conservation Council was created in September 1998, its members have addressed crucial issues in the annual reports, background papers and advisory publications. Extensive public consultations have been held across the province. Several significant government decisions, in fields such as coho rebuilding and the proposed Wild Salmon Policy, have been influenced by the information, analysis and ideas presented by the Council. Issues have been pursued in meetings and briefings with ministers, deputy ministers, elected officials and the news media to encourage the adoption of more effective salmon conservation policies and priorities.

The Council has been charged with the responsibility to provide strategic advice from a long-term perspective to the Minister of Fisheries & Oceans Canada, the British Columbia Minister of Fisheries, and the general public. It has been called upon to perform several crucial functions that include:

- identifying salmon stocks in need of conservation action;
- describing freshwater and marine ecosystem conditions;
- recommending research, stock assessment, and enhancement measures; and,
- integrating scientific and aboriginal ecological knowledge in the development of salmon conservation policies and practices.

The Council members' interpretation of their objective was stated in the Chair's June 1999 letter to the Ministers:

> *We strongly believe, as a Council, that there must be a clearer conservation strategy to enable everyone involved with salmon - including governments, First Nations, stewardship groups, fishers, communities and interested public - to work towards common goals with mutually reinforcing effort.*

The purpose of the Pacific Fisheries Resource Conservation Council is not to be just another advocacy group. Instead, it is intended to ensure the provision of pertinent public information and to lead an informed debate over the direction of fisheries policies.

6.1 Council's Role and Activities

The primary interest and concern of the Pacific Fisheries Resource Conservation Council could be described as being for the health and well-being of British Columbia's wild salmon and steelhead. As an advisor to governments and as an information source for the Canadian public, the Council has a unique conservation role. It was established to ensure that British Columbians would be given greater access to information about salmon and steelhead stocks and habitat conditions. It was meant to serve as a catalyst to establish the transparency in fisheries decision-making that was typically absent in the Pacific fisheries.

The Council has adopted a constructive attitude towards its relationships with the federal and BC governments. The purpose of this strategy has been to be both critical and supportive of initiatives and decisions, wherever appropriate.

For example, the Council has persisted in advancing the case for an extensive new research project and action to address the disturbingly high mortality of late-run Fraser River sockeye. The Council's position was put forward most recently by Council member Murray Chatwin in a presentation to the House of Commons Standing Committee on Fisheries and Oceans, in which he said:

> *We believe that the dimensions of the problem may become more staggering*

> *unless decisive action is taken soon. Facing the risk of extinction of the late-run Adams River stocks, the future of Canada's most valuable sockeye cannot be taken for granted. For example, the Pacific Salmon Commission staff have estimated that a continuation of the 90% rate of pre-spawning mortalities in the Adams River would bring a decline in escapement from 1.4 million to only 6,000 during the next twenty years, regardless of fishing restrictions.*

Murray Chatwin went on to explain the Council's position:

> *We have suggested that the research money in this instance should come from accounts set aside to cope with crisis conditions, not simply re-allocate existing research budgets in Fisheries & Oceans Canada and the Pacific Salmon Commission that are already squeezed to their limit and are insufficient for the tasks they must perform.*

The Council's February 2002 consultation in Victoria brought together federal and provincial government officials with a group of stakeholders for a forthright discussion of the issues raised in last year's annual report. The public consultation discussions at that time also revealed suggestions by several stakeholder groups about improving the effectiveness and accountability of the Pacific Fisheries Resource Conservation Council. It was proposed that a stronger advocacy stance should be taken by the Council on most matters, including aquaculture, and that more had to be done to engage the public in fisheries issues. The Council should also take the initiative in identifying the appropriate fisheries roles of the two levels of government and forcing some clarification of where responsibility lies in the face of extensive budget cuts and regulatory changes.

The Chair of the Council has been conducting informal meetings with government ministers and stakeholder representatives to provide briefings on the Council's positions. In each case, the importance of maintaining the fishing restrictions on coho has been repeated. The rebuilding of coho stocks is of vital importance, and the progress made so far towards that objective should not be undermined by a too-early easing of the current fishing restrictions.

Another issue that is continually emphasized is the need to address the cross-border salmon issues, particularly for the Okanagan region and its sockeye stocks. The value of harmonizing the work of several government agencies in both countries is obvious, but considerable work is required to link the conservation constituencies on both sides of the border and to recognize the mutual interests in pooling resources, standardizing assessment methodology, and sharing benefits from an ecosystem perspective.

Some of the higher profile activities and events sponsored by the Council since its inception are listed in the chronology contained in this report's Appendix 7.

6.2 Structure of the Council

The Pacific Fisheries Resource Conservation Council has undergone a review and restructuring of its operations and mandate that led to new administrative procedures and staffing arrangements, including the hiring of Gordon Ennis to serve as the Council's operational manager.

In addition to the transition to a more effective administrative structure, it has become apparent that the Government of British Columbia has not yet taken the more active participatory role that had been anticipated three years ago. While a Council member representing the provincial government was appointed in June 2000, there was no follow-up in terms of direct financial sponsorship. The in-kind support last year, however, in the form of the time and expertise of a senior biologist for several weeks, was a generous contribution by the Government of British Columbia. Provincial government officials have also participated in meetings, briefings and informal discussions, and they have proven to be informative and forthcoming on all occasions when asked to assist the Council in its inquiries.

Correspondence with BC Government officials during the past several months has shown their endorsement of the concept of the Pacific Fisheries Resource Conservation Council. Budgetary pressures may continue to preclude any financial support for the time being, but discussions are continuing and they reflect the productive relationship between the Council and the BC Government.

The matter of BC Government sponsorship of the Council will be on the agenda for ministerial discussions later this year. It is hoped that the original vision of the Council as an organization that is funded equally by both levels of government can still be ratified, and that the value of it to the BC Government will be fully recognized through sponsorship.

An exceptional capability of the Council as an organization has been evident in its reporting relationships to both federal and provincial levels of government. This position in addressing conservation issues across both governments' jurisdictions has been especially important for salmon and the inherent links with water quality and quantity. Regardless of the sponsorship decision of the BC Government, the Council will continue with its report to both levels of government and the public.

6.3 Building Capacity and Exerting Influence

A primary objective of the Council is to present a conservation perspective on current and emerging issues and their environmental, economic and policy context. In order to achieve it, some crucial changes have been made to reshape its ability to fulfil its mandate and satisfy public expectations. This includes significant staffing and program adjustments to achieve the objective more effectively.

The Council has arranged an executive interchange with Fisheries & Oceans Canada to enable Dr. Brian Riddell to join the staff as a science advisor to the members. He began serving on a part-time basis late last year, and started on a full-time basis in April. Dr. Riddell is a renowned fisheries scientist who is taking a hands-on role in several key projects during the coming year.

A new internet web site was developed for the Council, and has been in place since February 2002. It is meant to establish an initial building block of public information about current fisheries conservation issues and provide links to governments, fisheries researchers, non-government environmental organizations, and voluntary groups with an interest in salmon and their habitat. The possibilities of expanding it to serve as an interactive link and discussion site are being investigated.

The Council's role in acting as a primary source of public information about salmon will be given more attention in the coming year, with the development and implementation of a communications strategy directed at groups and communities having a particular need to be aware of salmon and habitat status.

A crucial test of the Council's effectiveness is in its ability to gain the attention of governments and provide the ideas and information that are needed to make timely and effective conservation decisions. The Council is building its media relations and public communications capacity in order to provide more direct leadership on salmon conservation issues during the coming year. The task of informing governments with clear advice and mobilizing public support and pressure for decisive conservation action on salmon and steelhead will be the primary objectives pursued by the Council in the coming year.

6.4 Council Agenda

For the past three years, the Pacific Fisheries Resource Conservation Council has pursued its workplan agenda with a focus on reinforcing its positions on coho stocks restoration, habitat investment, and funding for scientific knowledge to drive fisheries decision-making. At the same time, a series of studies, reports, events and advisories has been initiated to serve as its primary activities and outputs.

For the current year, the Council has several projects underway. One is a review of the notion of over-spawning as it relates to fisheries management strategies. The Council was asked last year by then-federal Fisheries Minister Herb Dhaliwal to analyze the over-spawning concept and provide input and advice in a brief report.

Another review initiated at ministerial request is the consideration of low water levels that could pose significant problems for returning salmon stocks. The salmon impact of the recent drought conditions in Washington and Oregon provide vivid examples of what could be in store for British Columbia. The Council hopes to produce an interim report this year, and complete its study in 2003. A feature of the study will be to raise public awareness and involve citizens in the Council's consideration of the options to reduce risks to salmon from low water conditions.

The Council is sponsoring a project to consider the issues related to the highly charged public debate about salmon aquaculture and wild salmon. It will look at the state of current knowledge about the controversial issues, sift through the various information and points of view, and examine the strength of the science that is used to support the various points of view.

The Council is committed to the production of a report addressing the cross-border issues relative to the Okanagan sockeye and their habitat. It is expected to proceed soon and be completed by year-end.

The implementation plans for the Wild Salmon Policy will be foremost on the Council's agenda when they are made available for review later this year.

In pursuing its work, the Pacific Fisheries Resource Conservation Council is guided by the findings and views expressed in the 1995 report of the Fraser River Sockeye Review Panel. In its report, the panel commented on the role of the public in British Columbia and the perspective that people must take:

> *Our responsibility goes beyond the boundaries set by interest groups, stakeholders, sovereign states and the chronology of time, which marks each passing generation. This is about these magnificent fish, and all of us, who have a tendency to destroy, but also the capacity to protect and conserve. No one owns the fish; even less does any particular interest group. This resource is held in trust by all Canadians for each succeeding generation of our peoples.*

7. Follow-up to Previous Reports

The responses, especially by governments, to the information and recommendations contained in the Council's reports and background papers are crucial indicators of their impact and effectiveness. This chapter summarizes the action and feedback that were noted during the past year, particularly related to five matters: ocean conditions; habitat issues; community advisors; wild salmon policy implementation; and resource management approaches.

It is regrettable that both the Government of British Columbia and Fisheries & Oceans Canada have failed so far to respond formally to the Council's December 2001 report on the preceding year. While officials in those governments had considerable challenges in their work, it can be hoped that their lack of attention to the Council's report did not necessarily reflect an inability to explain how they would maintain their salmon and steelhead conservation mandate.

7.1 Ocean Factors

Last year's annual report set out an exhaustive explanation of ocean conditions and the growing body of information about the significance of ocean factors in determining salmon health and future prospects. It illustrated how recent higher productivity can be attributed to changes in climate and availability of food for salmon in the ocean.

The combination of changing ocean conditions and in some locations deteriorating fresh water conditions, had previously resulted in major decreases in survival and production of wild salmon and many other fish species, and marine birds and mammals. With more favourable ocean conditions, there are indications that survival is improving and that stocks may eventually rebuild to acceptable levels.

However, scientific understanding of ocean climate change and its impact on salmon stocks remains primitive and little can be said with confidence about long-term trends, especially in the presence of global climate change.

7.2 Habitat Issues

The tasks of protecting and restoring habitat have been the focus of increasing public involvement and awareness across British Columbia. The voluntary effort of people from all walks of life to rebuild salmon passages and spawning areas has been one of the most heartening trends of the past two decades.

The government program structure and funding arrangements that support fish habitat efforts have been undergoing a major change. Last year's decision by the provincial government to shut down Fisheries Renewal BC has contributed to an overall decline in funds available to community groups, as more than $13 million per year was eliminated from fisheries programs. Coincident with the Fisheries Renewal BC closure was the Government of Canada's sunsetting of its habitat restoration fund and initiation of the Pacific Salmon Endowment Fund. This fund was meant to create a stable source of funding to go into habitat-related projects in critical watersheds.

The increased interest of the Council in ocean-related salmon issues should not be interpreted as a lessening of concern about freshwater issues. As water availability becomes increasingly rationed, freshwater habitat limitations are again becoming key factors in determining salmon production. The disruptions in spawning and interference in migration continue to be habitat problems that plague the efforts to rebuild stocks. The attention of the Council to water issues, building on the work contained in its background papers during the past three years, will be demonstrated in upcoming reports, particularly those dealing with the impacts of low water levels in British Columbia lakes, streams and rivers.

7.3 Community Advisors

The Council's September 2001 background paper entitled *The Role of Public Groups in Protecting and Restoring Freshwater Habitats in British Columbia, with a Special Emphasis on Urban Streams* drew considerable amount of positive comment, but some readers also expressed concern that government programs designed to support and foster the efforts of public groups were not elaborated upon. Many respondents noted that this background paper provided recognition of the wide-ranging volunteer effort in habitat issues across the province, which is what the authors set out to do. At the same time, some suggested that the paper did not depict how the role of key positions, particularly Community Advisors, has evolved over the past two decades in support of the work of public groups.

The Council's background paper on public groups was intended to draw attention to the need for continued support for community organizations involved in salmon habitat projects that most respondents consider a timely message. However, it is important to give due recognition to the role of Community Advisors and the pivotal role this position plays in habitat initiatives and community education. Other positions that also support or complement the activities of public groups include Habitat Stewards, Habitat Fishery Officers, Stewardship Coordinators, and Habitat Auxiliaries. Fisheries & Oceans Canada is commended for supporting the programs that enable these positions to be maintained. In light of current trends relating to public involvement, the Council believes there may well be a necessity for more positions of this nature in the future. The Council is concerned that some of the programs, such as Stewardship Coordinators and Habitat Auxiliaries have sunset dates that may lead to decreases in capacity and activity if they are not renewed.

The Council's background paper on public groups also elaborated on three case studies that were meant to be examples of successful habitat protection and restoration initiatives. However, as the authors indicated, there are many other projects that could be mentioned, just two of which are Project Watershed and Veins of Life.

When the Community Advisor position was first created in the early days of the Salmon Enhancement Program, there was a particular emphasis on artificial or "hard" enhancement measures, including new hatcheries. There has been a significant evolution of this program and, today, the Community Advisor has become an essential and highly visible link between public stewardship groups and Fisheries & Oceans Canada officials, supporting and helping to channel voluntary contributions of people across the province.

As part of the evolution of the perspectives of the Community Advisors and of the Salmon Enhancement Program, there is now a greater appreciation of the need for an array of strategies to manage rivers and streams, ranging from the pro-active protection of habitat to the restoration of waterways. This progression towards a balance of enhancement and wild salmon conservation, combined with a dramatic upsurge in the number of public stewardship groups, has expanded and complicated the job description of the Community Advisor, a position that is unique within Fisheries & Oceans Canada.

From a facilitation perspective, the Community Advisor is ideally placed to build rapport among volunteer organizations and enable them to effectively supplement the work of professionals and technicians in both the federal and provincial governments. It is widely acknowledged, for example, that the Community Advisors played a pivotal role in launching the streamkeeper program several years ago and successfully marshalling the enthusiasm and commitment of public groups for this effort. The Council has noted on previous occasions the pivotal role that public groups and community organizations have played in managing and protecting salmon waterways. It is timely to begin to acknowledge more explicitly the importance of the Community Advisors in nurturing and contributing to this success.

7.4 Wild Salmon Policy Implementation

The process of formulating a comprehensive and practical federal government policy on wild salmon has been, in the view of many British Columbians, painfully slow and overdue. However, it appears that Fisheries & Oceans Canada will be in a position to proceed later this year with public consultations on the implementation of a wild salmon policy statement that has been emerging from discussions that took place more than two years ago.

The implementation arrangements will be crucial to the success or failure of the new policy to enable effective salmon conservation to be the prevailing value and guiding principle. The Council has suggested that the policy should articulate a single, clear and unequivocal statement that wild salmon will enjoy management priority when it comes to making decisions about salmon on Canada's West Coast.

The initial draft of the policy that contained some significant flaws has been revised in light of the initial consultations and involvement by individuals and organizations from across the province. The wild salmon policy, as it was proposed in 2000, introduced new jargon and concepts in order to redefine how salmon populations can be more accurately identified, measured and protected. For instance, it calls for the assignment and use of "conservation units" as a basis for salmon stock management. It suggests conservation units that would be genetically defined groupings instead of the individual populations that presently serve as a basis for management. In most cases, the new approach would involve managing the populations of each salmon species within a geographic area as a single conservation unit.

What is currently referred in salmon management as the spawning escapement goal (i.e., the desired abundance of spawners in a population) would now be termed the "target reference point." This number of spawners would be identified for each conservation unit and expected to meet ecosystem needs and provide as much sustainable catch as feasible in a year. The minimum acceptable spawning escapement required to ensure the long-term viability of each conservation unit would be defined as the "limit reference point". Declines in escapement to levels approaching it would trigger fishing restrictions or other measures to ensure that the conservation unit would not be put at risk of extinction.

While the jargon is new, the concept of effective conservation responses is not. In fact, this new approach to fisheries management is already gradually being implemented. Its basis is the assumption that current scientific methods can measure the genetic differences between populations. A possible flaw, however, is that few genes are currently used for identifying conservation units, and there are some significant behavioural differences between and within populations that are apparently genetically the same. Also, policy implementation is limited by the lack of current information and resources to define the conservation units and set the most appropriate and valid reference points.

These implementation issues, as well as the requirements for selective fishing and impacts on non-target species in the commercial fishery, are among the ones expected to be reviewed thoroughly in the upcoming consultations.

The Council has discussed with Fisheries & Oceans Canada the possibility of serving in a convening role to enable full and even-handed public involvement in the establishment of the implementation process.

7.5 Resource Management Approaches

The BC government's adoption of results-based management in the fisheries and elsewhere was addressed in the Council's annual report last year. Since then, little has been done to allay public fears or provide reassurance to the Council that the new management regime will be effective in preventing conservation problems for salmon.

Much of the proposed new policy direction is vague, leaving wide room for interpretation. From a managerial point of view, this flexibility may be desirable. However, the necessary clarity in conservation performance measures and the regulatory-change impact assessment process are still missing.

The lack of baseline information on local resources and current ecosystem conditions makes it impossible now to assess the long-term salmon impacts of the proposed changes in regulatory approach. Because of the high natural variation in salmon returns and health conditions, the cause and effect dynamics cannot be readily predicted. Moreover, they cannot generally be scientifically proven until the impacts occur and are observed several years from now. Even then, there are often other factors in play to make it difficult to attribute any impact on salmon to a specific cause. For example, it is often difficult to differentiate the effects of overfishing, climate change and habitat degradations, or to draw clear conclusions about the causes and effects.

In a recent speech, the Council Chair, John Fraser, described the situation in the following way:

> *The newly formed Provincial Government of British Columbia seems to be committed to less prescriptive ways to achieve streamside protection and there is talk of "streamlining" the Forest Practices Code and amending the Streamside Protection regulations to a "results-based" approach – whatever that means. We want to know exactly what effect this would have on particular streams and watersheds because, until some of this is explained in terms of what actually happens, "streamline" and "results-based" are just buzzwords.*

He went on to describe a more immediate and apparent consequence:

> *Here is a classic case of the Province being pushed to relax protection and, in the face of this possibility, others demanding that the federal Department of Fisheries and Oceans do its duty. We would argue that it's the obligation – to citizens of today and the communities of tomorrow – for both governments to do their duty, and each government should have the same objective – to sustain the habitat and the stocks. Any regulations and, equally, any regulatory change should be measured against that test.*

This new policy approach and how it is interpreted will evolve as the specific changes and spending plans are implemented. One way or another, they will determine the success or failure of the conservation of salmon resources long into the future. The Council is concerned that implementation of the policies may not strike the right balance between economic and conservation objectives, and may not be appropriately precautionary with regard to sustaining fish stocks and their ecosystems.

8. Recommendations

This report marks the first time that stock information on all species of Pacific salmon in southern BC and the Okanagan has been compiled in one document. The Council will continue to develop this report as it receives feedback, and will maintain it as a public reference on the website.

The fervent public debates on salmon in British Columbia demonstrate the emotional attachment of people to these fish and their remarkable lifecycles. The resilience and determination that characterize salmon have created a connection to humans and a public loyalty that is unmatched. Reading the newspaper headlines and editorial exchanges, British Columbians might believe that they have good reasons for becoming fearful or hopeless about the future of wild salmon stocks.

Indeed, there are challenges in the conservation of Pacific salmon and significant monetary resources and a strong public conservation ethic will be required to successfully meet those challenges. However, after about 150 years of development in BC, it is apparent to this Council that there remains a rich diversity of Pacific salmon populations and an abundance of salmon in many locations. In recent years, the negative focus on salmon conditions and disruptions to fisheries was consistent with a period of reduced survival of salmon in the ocean. Fortunately, improving conditions in the ocean and the conservation measures taken by governments and concerned fish user groups have led to greater salmon production and also contributed to a degree of recovery, particularly of coho salmon in southern BC. It is important to note that there have been successes in conservation, not just problems.

The Council believes that there remains a viable and productive future for Pacific salmon in southern BC and the Okanagan. It will require attention to habitat protection and restoration and an adequate empirical basis for research, stock assessment, management and enforcement, as well as a strong basis in public understanding and support. This report demonstrates that a broad fisheries resource base remains, but in many examples the recent escapement levels were substantially reduced from the past. The Council notes that care must be taken to avoid complacency about current conditions and ensure that restoration of habitats and stocks will be a major component of salmon conservation in the future. The slow ratcheting-down of expectations over generations (the shifting base line phenomena) due to short-term assessments and attention to crises, if allowed to continue, would ultimately lead to the accumulation of even worse losses of salmon production and populations. An investment in higher-level stock reviews, such as those suggested in this report, will be essential.

In light of the findings and analysis chronicled in this report, the Council is making the following recommendations:

1) Okanagan Salmon:
   There is an immediate need for dedicated resources for annual monitoring and research into the factors that limit the production of sockeye salmon at each life history stage, both in the Okanagan basin and their broader ecosystem outside of this basin. The opportunity to restore Okanagan sockeye production and one of Canada's most disturbed ecosystems remains, but the task is inherently long-term and will be costly. Stakeholders and local institutions should identify a lead organization to serve as the focal point for cross-border initiative, and establish a communication process to ensure common understanding of goals and potential benefits and impacts on all users and communities.

2) Escapement Surveys:
   The inconsistency and questionable accuracy of spawning escapement surveys over time, areas, and species is a serious limitation to assessment of Pacific salmon in southern BC. This is a recurring theme in all of the regions and requires immediate attention, particularly as discussion abounds concerning further budget reductions in Fisheries & Oceans Canada. Not every stream needs to be surveyed every year, but consistent and repeatable survey conducted within an overall assessment framework is required for responsible monitoring. While this issue has been identified for many years and left unresolved, it must be addressed soon.

3) Hatchery Assessment:
   This Council strongly recommends an objective assessment of the net benefit of hatchery production of Pacific salmon and the ecological interactions of hatchery fish with naturally-produced salmon. Despite the significant output of juvenile salmon from hatcheries, recent years have demonstrated that a consistent overall increase in salmon production has not resulted. The Council acknowledges the polarization in the views of many stakeholders about hatchery production, and that the situation differs between species and areas. However, the positive and negative consequences of enhancement have gradually become evident during the past several years, and the hatchery policies should be reviewed in an open and transparent public forum.

4) Conservation Concerns:
   The Council has acknowledged the successes in salmon conservation, but there are continuing concerns in southern BC that require attention, particularly in the following:
   - Protection and restoration of Okanagan sockeye spawning and rearing habitat;
   - Precautionary management of early-run Stuart River sockeye salmon;
   - In-depth assessment of the late-run Cultus Lake sockeye salmon and development of management responses to ensure preservation and restoration of this stock (applies to other small Fraser sockeye lakes also);
   - Examination of the stock status of the many small-lake sockeye salmon populations in the Strait of Georgia and along the West Coast of Vancouver Island;
   - Precautionary management of coho in southern BC that should continue until consistently improved production of coho salmon is evident;
   - Monitoring and assessment of remnant chinook populations in the Strait of Georgia (Nanaimo River spring chinook, Puntledge River summer chinook) and investigation concerning the recent limited production of the remaining production of chinook in Nimpkish Lake drainage;
   - Examination of the odd-year Pink salmon production in the Johnstone Strait and along the West Coast of Vancouver Island; and,
   - Continued investigations into the Late-run Fraser River sockeye salmon issues.

   Conservation of the late-run Fraser River sockeye salmon, including the Adams River and Cultus Lake runs, remains the major concern in BC. The current abundance of Cultus Lake sockeye salmon is critically depressed and requires immediate attention to conserve this late-run sockeye population. The Council supports the fishing restrictions during 2002 to preserve this important salmon run. However, the limited research program and subsequent suspension of some recommended studies have impaired the potential for achieving a better understanding of this severe problem. The Council urges Fisheries & Oceans Canada to maintain its conservation restrictions and direct greater effort and resources into research to determine the causes and formulate mitigation measures, if necessary.

Council also reiterates its recommendations from our last annual report, including the need for scientific data and evidence-based research on ocean survival as related to the understanding of the key factors affecting Pacific salmon production. Long-term salmon management strategies and monitoring must be adjusted to account for ocean productivity and climate change.

5) Government Responses:
The Council notes that some issues identified in this report have been addressed in previous advisory group reports to government, but have had little response. This appears to reflect a problem of accountability of the federal and provincial governments to act on the advice or explain why they are unwilling or unable to do so. Both levels of government should commit to providing timely and complete responses to the advice conveyed by this Council and the Pacific Scientific Advice Review Committee (PSARC). Public reports on the issues raised by advisory groups and the responses should be prepared by both governments. Such an initiative could significantly enhance the openness and accountability of their fisheries management activities.

Further, the Council notes that few of the stocks considered in this report have formal stock assessments completed. This limitation is important to address to ensure that appropriate data are being collected and that the status of the Pacific salmon resource is being monitored responsibly.

The Council wishes, though, to note the increasing availability of public information about the salmon resource and the effort of federal and provincial governments to improve the availability of documents and data. During the past few years, for instance, a much larger number of the papers discussed by PSARC are being finalized and provided through the internet. Furthermore, PSARC stock status reports provide brief descriptions of important salmon stocks and the Proceedings series chronicle the advice being provided to fisheries managers. This, in turn, improves the availability of important information and could provide for greater accountability to the public.

Appendix 1 - Summary of recent trends in production of Fraser River sockeye by stock

Appendix 1. Summary of recent trends in production of Fraser River sockeye by stock (data provided by Pacific Salmon Commission). Characteristics of each stock recorded by the PSC are listed and comments provided on recent production versus long-term production trends (+ indicates increasing production, - indicates decreased recent production, and NE indicates no long-term trend is evident, UNK indicates unknown). This summary indicates increasing production in 10 stocks, no long-term change in 7, decreasing production in 7, and unknown trend status in 6 (total n=30).

Stock Name	Timing Group (Management unit)	Main Tributary system	Years of Surveys	Comment	Trend
Adams River (lower section) *Appendix figure A2.1*	Late Summer	South Thompson River, flows into Shuswap Lake	1954-2001	Strong 4-year cyclic dominance with dominant cycle in 2002, historically the large single sockeye population but decreased production in recent yeas. Stock associated with late-run sockeye issue and high pre-spawn mortality.	(-)
Adams River (upper section)	Early Summer	South Thompson River, flows in to Adams Lake	1988-2001	Major restoration effort starting to show benefits, increased production on 2000 cycle year	(+)
Anstey River	Early Summer	South Thompson River, Shuswap Lake, Anstey Arm	1992-2001	Production strongest on 2002 cycle year, sub-dominant production on 2003 cycle	UNK Short time series
Birkenhead River	Late Summer	Lillooet River, flows into upper Lillooet River	1954-2001	No cyclic dominance evident, decreased production through 1990s but forecast for increased returns in 2002.	(-)
Bowron River	Early Summer	Upper Fraser River, above Prince George	1954-2001	Cyclic dominance no longer evident, long term decline in production estimated, recent production quite depressed.	(-)
Cayenne River Momich River	Early Summers Late Summers	Upper Adams Lake, South Thompson River	1990-2001	Recovery maybe associated with Upper Adams River work, increased production on 2000 cycle year	UNK
Chilko River *Appendix figure A2.3*	Mid Summers	Chilcotin River, mid-Fraser River	1954-2001	Production cycles but no fixed cycle year is evident, recent production has declined from record high production to approximately 1 million sockeye annually, similar production expected in 2002	NE
Chilliwack Lake	Early Summer	Chilliwack River, lower Fraser River	1980-2001	Small stock but with increased production in recent years, data quality uncertain.	(+)

Stock Name	Timing Group (Management unit)	Main Tributary system	Years of Surveys	Comment	Trend
Cultus River *Appendix figure A2.8*	Late Summers	Lower Fraser River	1954-2001	Production cycles have broken down, recent production very depressed and now a conservation concern, maybe associated with late-run sockeye mortality issues.	(--)
Eagle River	Early Summers	Shuswap Lake, South Thompson River	1991-2001	Limited data, very strong production cycle on 2002 year but little other production	UNK
Fennel Creek	Early Summers	North Thompson River	1968-2001	Relatively small stock without cyclic production, no long term trend in production but recently declining.	(-)
Gates Creek & spawning channel *Appendix figure A2.2*	Early Summers	Flows into Anderson Lake, east of Lillooet	1954-2001	Strong cycle of production in 2000 year, long term trend is increasing.	(+)
Harrison River	Late Summer	Outflow of Harrison Lake, lower Fraser River	1954-2001	No cycles in production but recent inceasing trend is reversing a period of decline, monitored for late-run sockeye mortality issue.	(+)
Horsefly River *Appendix figure A2.4*	Mid Summers	Flows into Quesnel Lake and then Quesnel River	1954-2001	Strongest population in Fraser currently, cyclic production on 2001 cycle but 2002 cycle is also building.	(++)
Lower Shuswap River	Late Summers	South Thompson, flows into Mara Lake	1954-2001	Strong production cycle in 2002 year but very little otherwise, major decrease in 1998 return maybe associated with late-run sockeye mortality issue.	(-)
Mitchell River	Mid Summers	Upper Quesnel Lake	1982-2001	Strong production cycle in 2001 year but little other production, no long-term trend	NE
Nadina River & spawning channel	Early Summers	Flows into Francois Lake, upper Nechako River	1954-2001	Production has been quite variable but very strong in year 2000, no long-term trend is evident.	NE
Nahatlatch River	Early Summers	East of Fraser canyon	1981-2001	No long-term trend is evident but recent production is relatively poor compared to late 1980s production.	NE
Pitt River (and hatchery)	Early Summers	Upper Pitt Lake, lower Fraser River	1954-2001	No cyclic dominance but recently production improving compared to previous declining trend.	(+)

Stock Name	Timing Group (Management unit)	Main Tributary system	Years of Surveys	Comment	Trend
Portage Creek	Late Summers	Between Anderson and Seton lakes	1955-2001	Relatively small stock with variable production estimates, no cycle but show increasing trend in production.	(+)
Raft River	Early Summers	Upper North Thompson River	1954-2001	Relatively small stock but with stronger production in 2000 cycle year, recently each year is increasing in production.	(+)
Scotch Creek	Early Summers	Shuswap Lake, South Thompson River	1970-2001	Cyclic dominance on 2002 year but other years very limited production, recent cycle years remained strong.	(+)
Seymour River	Early Summers	Upper Shuswap Lake, South Thompson River	1954-2001	Cyclic dominance on 2002 year but other years limited production, recent cycle years declining in production.	(-)
Stellako River	Mid Summers	Flows into Nechako River, upper Fraser River	1954-2001	No evidence of cyclic dominance or long-term trend in production.	NE
Stuart River (early run group) *Appendix figure A2.6*	Earliest run timing group, June in lower Fraser River	Stuart River, above Prince George (32 spawning streams)	1954-2001	Highly variable production over time but no long term trend in production, forecasts for 2002 are poor.	NE (-) in 2002
Stuart River (late timing group) *Appendix figure A2.5*	Mid Summers	Stuart River, above Prince George (7 spawning streams)	1954-2001	Strong cyclic dominance on 2001 year but production decline substantially in 2001, poor return forecast for 2002, high uncertainty in trend but no long-term trend is evident.	NE (-) in 2002
Taseko River	Early Summers	Flows into Chilko River and then Chilcotin River	1988-2001	Best observed production in 1988 but much less since.	UNK
Weaver Creek & spawning channel *Appendix figure A2.7*	Late Summer	Harrison River, lower Fraser River	1954-2001	Long-term trend is positive but recent production is quite variable, stock is associated with late-run sockeye mortality issue.	(+)
Widgeon Creek	Late Summer	Lower Fraser River slough, Pitt Lake	2000-2001		UNK
Big Silver Creek	Late Summer	Flows into Harrison Lake, lower Fraser River	20001		UNK

Appendix 2 - Figures of historical production of sockeye salmon from the Fraser River 1954-2001, and their 50% confidence range about the 2002 forecast return.

Figure A2.1

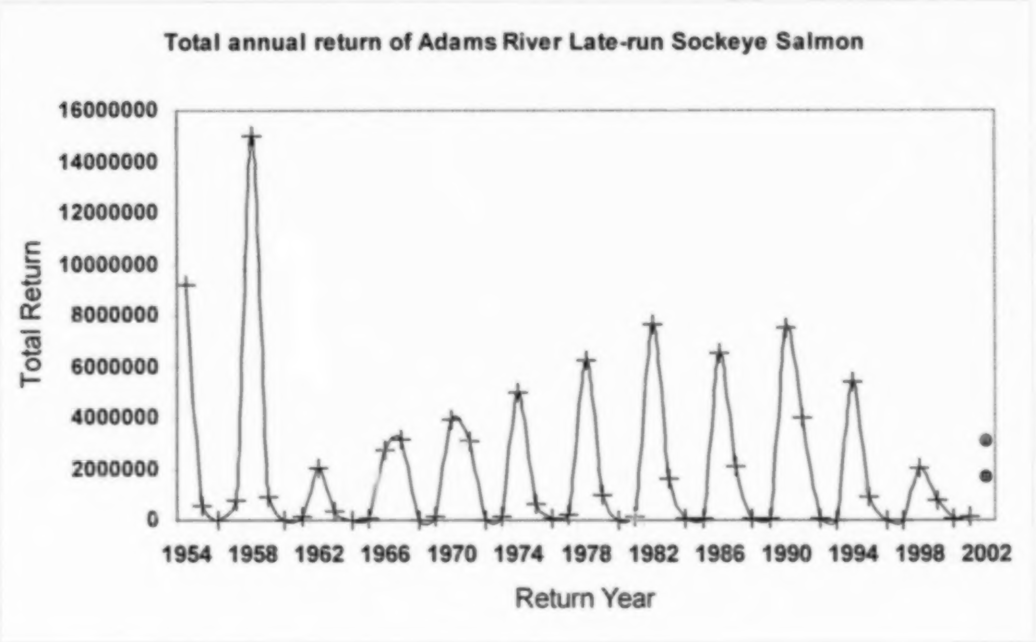
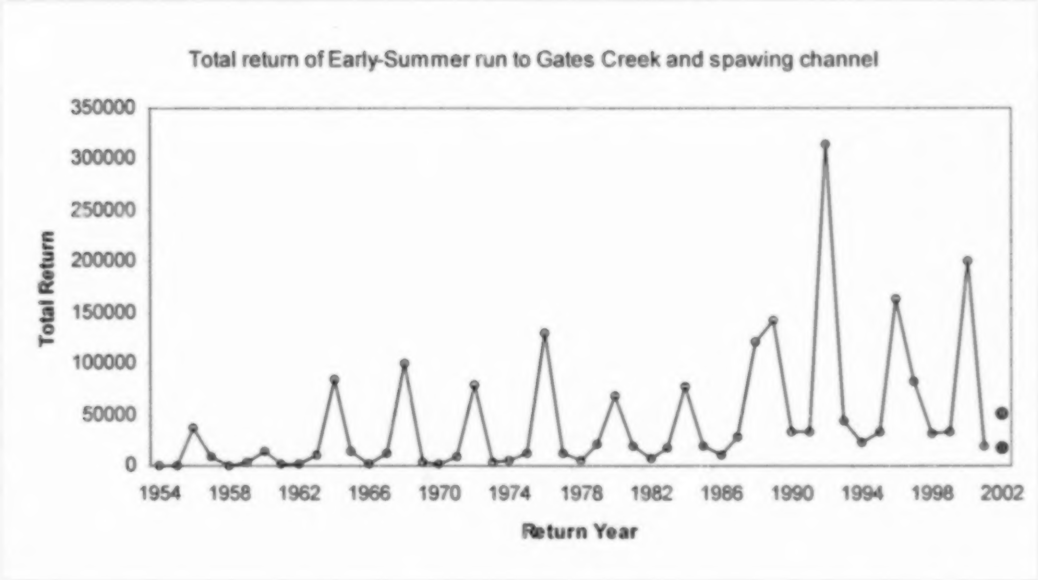


Figure A2.2



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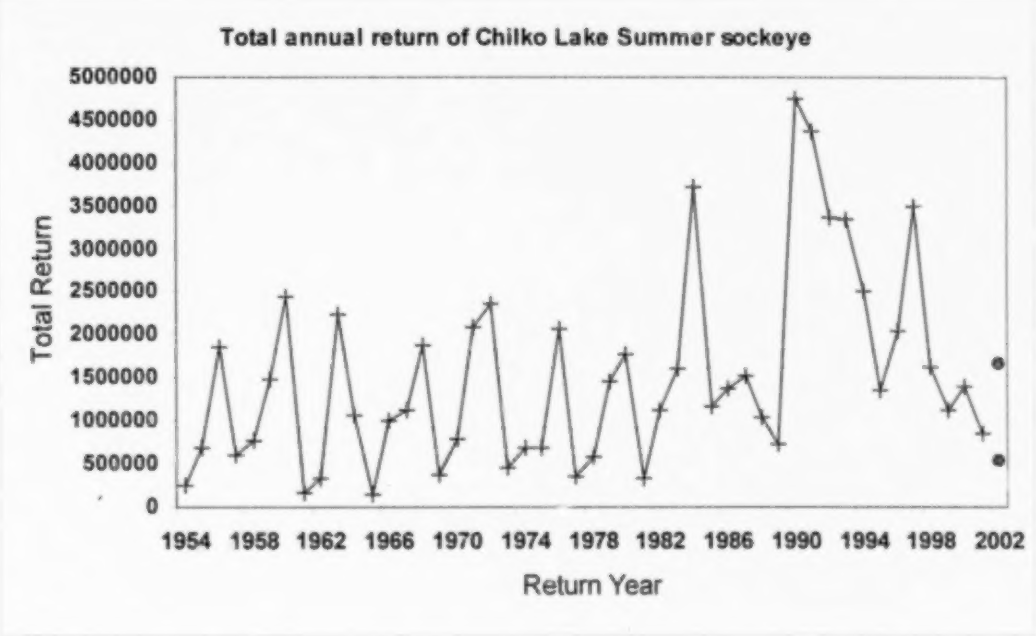


Figure A2.4

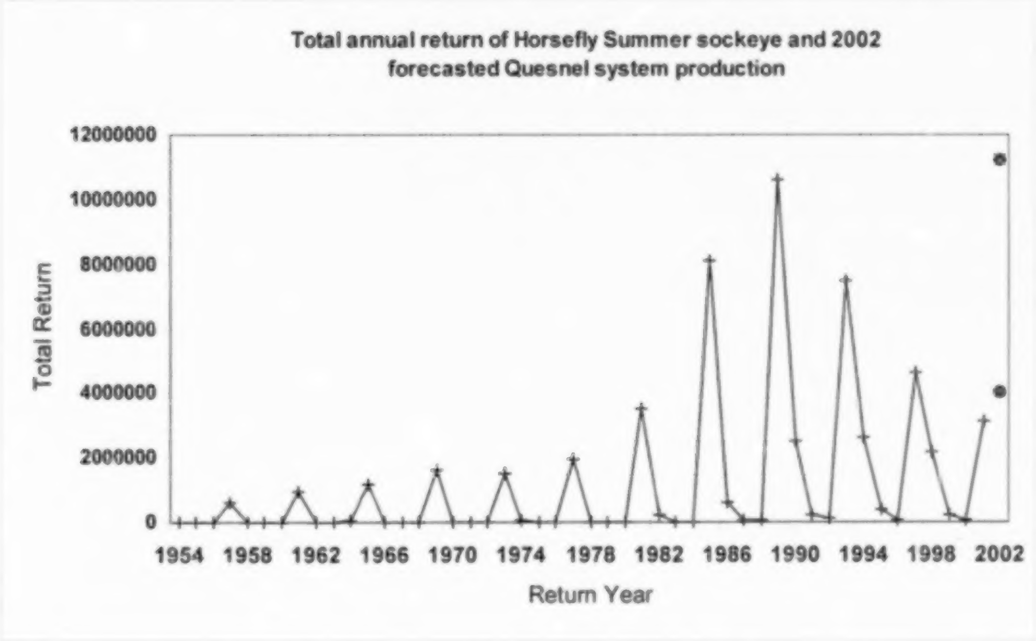


Figure A2.5

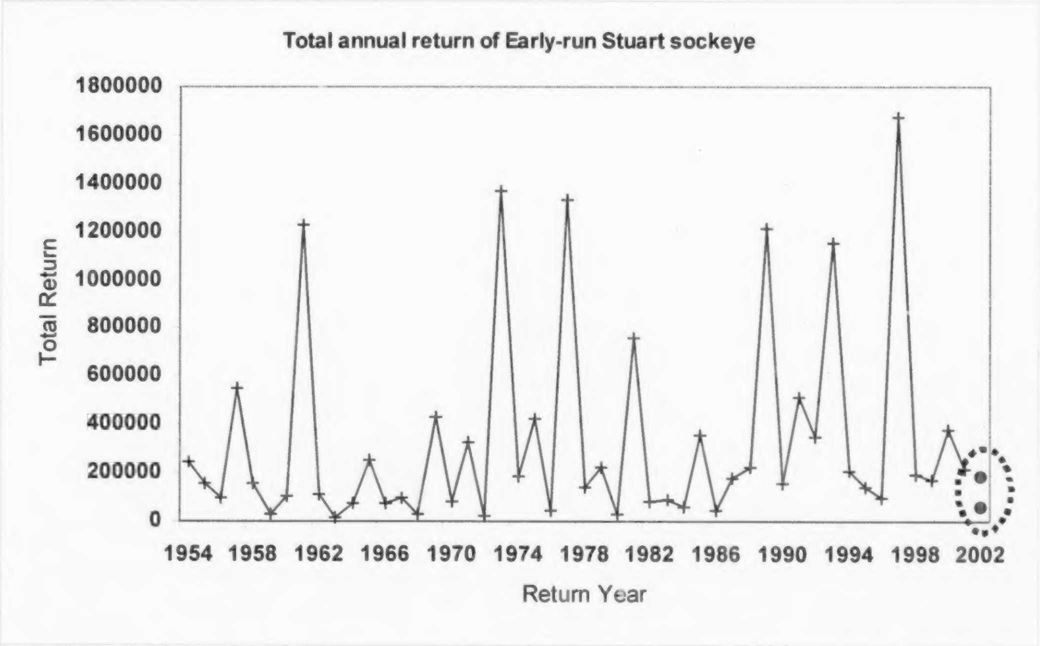


Figure A2.6

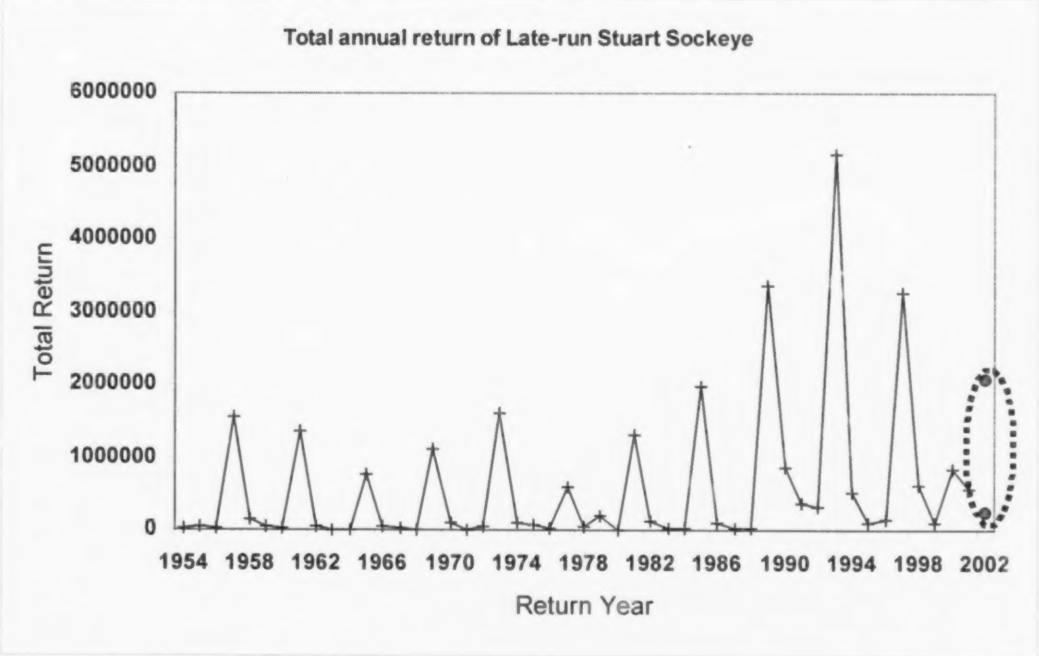


Figure A2.7

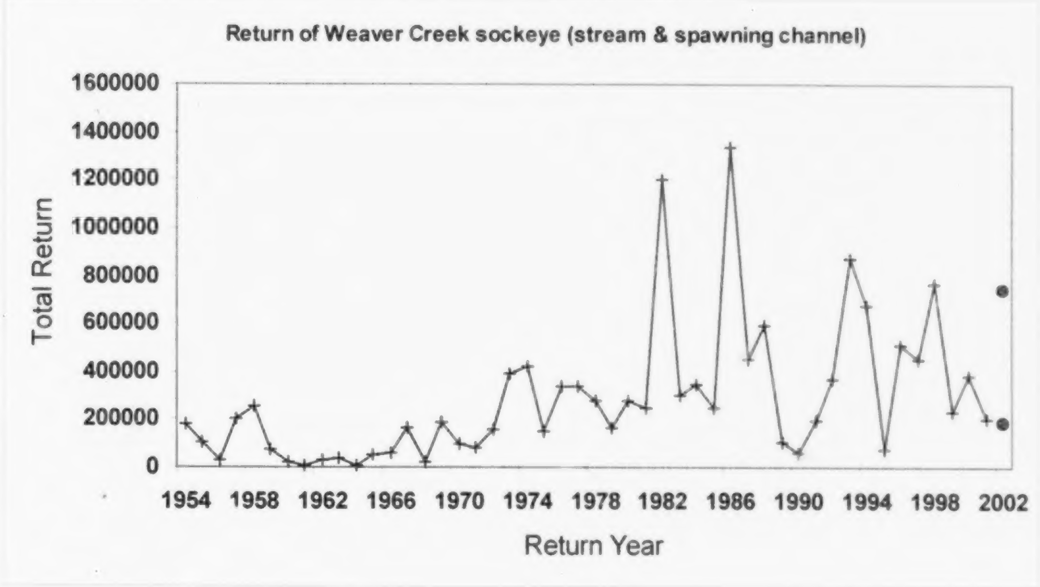
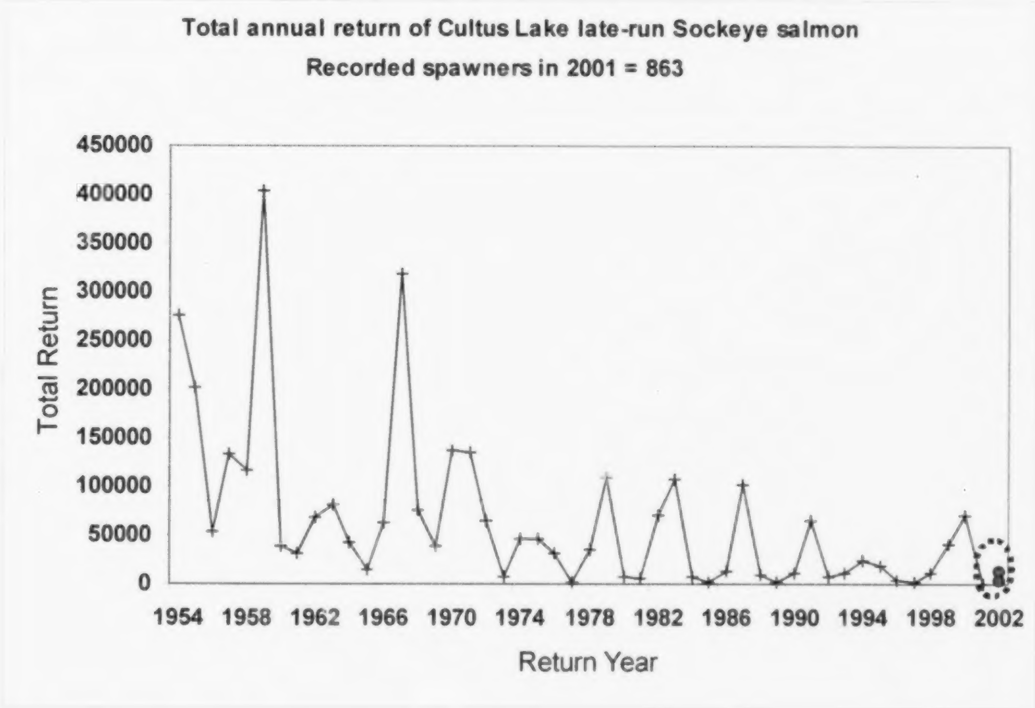


Figure A2.8



Appendix 3 – Summary of spawning escapements to chum populations in the Inner South Coast chum aggregate.

***Appendix 3**. Summary of spawning escapements to chum populations in the Inner South Coast chum aggregate. Data were summarized from Ryall et al. (1999) for the years 1953-1997 (n=45 years), but the summarizing statements were prepared by the PFRCC. Escapement trends are based on Figures 4.4 and comments on escapement surveys were based on Table 4.1 in Ryall et al.*

Stock group by geographic region	Description of location	Summary of escapement status	Frequency of enumerations	General trend in escapements
1. Seymore/ Belize Inlet	Northern most region of ISC chum, mainland inlet in lower Queen Charlotte Sound	Region contains 19 relatively small populations, overall escapement has only averaged 22,000 based on 1953-97, stock not harvested in Clockwork fisheries	12 of 19 populations have been surveyed at least once in every two years	Slight decline over long term
2. Upper Vancouver Island	North end of Island down to Cluxewe River	Region contains 8 chum systems but escapements very depressed since 1970s, total escapement currently in hundreds	4 of 8 populations have been surveyed at least once in every two years	Long term decline in escapements
3. Kingcome Inlet	Mainland area, lower Queen Charlotte Sound	Region contains 16 chum systems, total escapement currently only a few thousand and less than 1% of management goal	5 of 16 populations have been surveyed at least once in every two years (each of these was historically a moderate sized stock)	Long term decline in escapement except in mid 1970s
4. Bond & Knight Inlets	Mainland area, upper Johnstone Strait	Region contains 24 chum systems, total escapement currently several thousand but less than 1% of management goal	13 of 24 populations have been surveyed at least once in every two years; most small populations not surveyed, surveys of larger stocks much more consistent	Steady long term decline in escapement
5. Johnstone Strait	Vancouver Island, Port McNeill to Campbell River (streams do not include Quinsam or	Region contains 14 chum systems including the Nimpkish River stock. Nimpkish accounts for >90% of escapements over past two	8 of 14 populations have been surveyed at least once in every two years, 4 of the streams not surveyed were	Total escapement increasing but due to Nimpkish and Fulmore rivers. 12 of 14 systems

Stock group by geographic region	Description of location	Summary of escapement status	Frequency of enumerations	General trend in escapements
	Campbell rivers)	decades	very small populations (tens of spawners)	have declined substantially
6. Loughborough & Bute Inlets	Mainland area, mid Johnstone Strait	Region contains 35 chum systems including major production in the Southgate River (3 to 4 streams account for >90% of total escapement). Trends in smaller systems are highly variable.	24 of 35 populations have been surveyed at least once in every two years; 7 of the streams not includes are very small with <100 spawners observed	No clear trend but escapements since 1970 larger than previously
7. Mid Vancouver Island	Vancouver Island, Campbell River to Nanoose Bay	Region contains 33 chum systems including 3 major hatcheries	22 of 33 populations have been surveyed at least once in every two years, 15 of these were surveyed 40+ times in 45 years; all others are very small systems.	Quite consistent returns to most large systems but several smaller systems show long term declines
8. Toba Inlet	Mainland area, upper Strait of Georgia	Region contains 15 chum systems and very small returns during the 1990s (<1,000 annual average)	9 of 15 populations have been surveyed at least once in every two years, 4 of the others are very small (only a few spawners recorded)	Very limited returns recorded for 1990s but fewer surveys conducted, trend is uncertain.
9. Jervis Inlet	Mainland area, central Strait of Georgia	Region contains 36 chum systems, escapement quite consistent over time; 5 systems account for majority of escapement but most other systems also show consistent returns over time.	Very consistent surveys; 23 of 36 populations surveyed 40+ times out of 45 years.	Increasing trend but significant declines in mid 1990s
10. Lower Vancouver Island	Vancouver Island, Nanoose Bay to Crofton	Region contains 18 chum systems including the Nanaimo River; significant reductions to most systems during 1990s except for Nanaimo R. and Haslam Cr.	9 of 18 populations have been surveyed at least once in every two years, 8 of these 9 surveyed 40+ times in 45 years; 7 of the others are very small populations	No long term trend but significant reductions in about one-third of the systems during the 1990s

Stock group by geographic region	Description of location	Summary of escapement status	Frequency of enumerations	General trend in escapements
11. South Vancouver Island	Vancouver Island, Crofton to Port Renfrew (excludes streams at Port Renfrew)	Region contains 9 chum systems with strong returns to Cowichan, Chemainus, Koksilah, and Goldstream.	4 of the 9 populations have been surveyed 40+ times in 45 years; all others systems are very small populations	Increasing trend but some decline in mid 1990s
12. Howe Sound & Sunshine Coast	Mainland area, central Strait of Georgia	Region contains 56 chum systems but Squamish watershed accounts for vast majority of returns.	15 of 56 populations have been surveyed at least once in every two years (over 45 years) … but the number of streams surveyed have increased by 2.5 time since 1970; only 7 systems have been consistently surveyed since 1953	Modest reduction in total return during 1990s but longer term trend is highly uncertain due to limited surveys in 1950s and 60s
13. Burrard Inlet	City of Vancouver	Region contains 13 chum systems but Indian River is the only significant producer	Only 3 of 13 populations have been consistently surveyed since 1953 (each with 39+ surveys in 45 years)	Increased escapements since 1980s.
14. Fraser River	Fraser River, south Strait of Georgia	Region contains 121 chum systems with recorded escapements and 7 have average escapements exceeding 10,000 chums annually.	41 of 121 populations have been surveyed at least once in every two years, over half of these have been surveyed 40+ times in 45 years. Many other populations are very small or infrequently inspected.	Increasing trend of escapement since 1950s but significant increases since 1980s, few localized systems show declining escapements
15. Boundary Bay	Mainland area, south of Fraser River	Region contains only 4 small chum systems	Campbell River is the only system that has been consistently surveyed (39 of 45 years).	No long term trend but populations very small with limited surveys.

Appendix 4 - Council Members

Hon. John Fraser (Chair), Vancouver

Mark Angelo, Burnaby

Mary-Sue Atkinson, North Vancouver

Frank Brown, Bella Bella

Murray Chatwin, Vancouver

Merrill Fearon, Vancouver

Paul LeBlond, Galliano Island

Jeff Marliave, Vancouver

Marcel Shepert, Prince George

Carl Walters, Vancouver

Richard Beamish (ex-officio), Nanaimo

Arnie Narcisse (ex-officio), Vancouver

Bibliographic for each of the above members is available on the council website at www.fish.bc.ca .

Appendix 5 - Glossary

Assessment – An evaluation of the productivity in a population of fish used as a basis for deciding the number of reproducing fish desirable and the recommended rate of harvest on this population.

Catch Year – the calendar year in which a catch occurs

Coded-wire tag – microscopic wire etched with an identification code. Tags are inserted into the nose cartilage of salmon to identify them.

DFO – Department of Fisheries and Oceans, also referred to as Fisheries & Oceans Canada, federal agency responsible for managing Pacific salmon and their habitats

Enhancement – man-made alterations to natural habitats or application of artificial culture techniques that will lead to increased abundance of juvenile salmon

Escapement – the number of fish escaping from a fishery. The escapement from all fisheries is the spawning escapement (i.e., the fish reaching their natal spawning stream).

Escapement Goal – a management target, the number of fish desired on the spawning ground. The goal maybe established based on maximizing yield, habitat capacity, or historical precedent.

Exploitation Rate – the percent of the production from a population that is killed by fishing. (The total fishing mortality, over all ages and fisheries, divided by the total production from one spawning year in a population). Usually determined for a spawning or brood year in order to account for mortalities over all ages.

FOC – Fisheries & Oceans Canada, previously known as the Department of Fisheries and Oceans, the federal government agency responsible for managing most Pacific salmon and their habitats

Habitat – area in which an organism would naturally be found; the place that is natural for life and growth of the organism.

Habitat capacity – the number of organisms that can make maximum use of the available habitat (may refer to spawning capacity for adults or rearing capacity of juveniles).

Harvest Rate – the percent of the abundance of fish in a fishing area (defined by gear, location, and timing) that are killed in that fishery. Also used to describe the percent of a single age class harvested by all fisheries, e.g., catch of Age-3 Coho salmon.

Homing – the ability of salmon to undertake long distant migrations to sea and return to the stream where they were produced (i.e., their natal stream).

Index Stream – a stream selected as being representative of other streams in an area.

Index Stock – a spawning population of fish that is monitored as representative of other populations of the same species in a proximal geographic area or habitat.

Line – used as in a line of descent or linage; in pink salmon and sometimes for coho salmon since production in a year comes from one year of spawning; e.g. the odd-year line of pink salmon can be defined since spawning only occurs every other year due to their fixed two-year life cycle. A line in coho salmon is determined by their three-year life cycle.

Monitoring – sampling of a stream or salmon population on a continuing basis; tracking and reporting on conditions of the environment and salmon.

PBS – Pacific Biological Station, Nanaimo.

Pacific Scientific Advice Review Committee (PSARC) – scientific peer review process for stock assessment and scientific information to be used by Fisheries and Oceans Canada.

Precautionary management – erring on the side of caution and conservation; the greater the uncertainties are the more that harvests and other impacts should be reduced to diminish conservation risks to the stock.

Population – a localized spawning group of fish that is largely isolated from other such groups. In Pacific salmon, these groups maybe adapted to their local environment due to the high fidelity of homing to their natal streams.

Production – the total number of fish produced.

Productivity – the rate of production per parent in a population. Frequently expressed as a ratio between the parent and the number of adult progeny they produce.

Rate of adult return – is used as a measure of productivity, and determined by the number of mature progeny produced from the number of spawning salmon in the parent generation. Mature progeny are fish returning to their natal streams, i.e., next generation of adults.

Return Year – the year that the fish returns to freshwater for spawning.

Salmon life stages – *alevins* emerge from eggs and reside in the gravel; *fry* emerge from the gravel and maybe reside in freshwater or migrate to the sea; *parr* are juveniles that reside and grow in freshwater; *smolts* are a transition phase from freshwater parr to seaward migrants and early The period of these stages differs between salmon species.

Spawning Year – the year in which eggs were fertilized, may also be referred to as the brood year.

Statistical Area – FOC has delineated the coast of BC into 30 regions for the purposes of accounting for catch by area and/or general locations of fisheries, streams, etc.

Stock – a genetically similar group of fish, usually returning to a specific geographic area and/or time period.

Stock Assessment – evaluation of the productivity of a stock as a basis for deciding escapement goals and sustainable exploitation rates. These analyses provide the basis for conservation, management, and restoration strategies.

Sustainable exploitation rate – the percent of the production that can be harvested at an escapement level and provide sufficient spawners to replace that level of production in the next generation.

Survival Rate – portion of the juveniles migrating to sea that survives to adult stages (usually determined by the sum of catches and escapements from a spawning year). Marine survival rate refers to survival of salmon entering the sea to adult stages but frequently also includes a period of freshwater downstream migration before sea entry.

Terminal harvest rate – the portion of a population's returning adults that are killed in fisheries that largely affect just on that population.

Total stock – the sum of catches and spawners (all returning fish) for a stock and spawning year.

Yield – at a specified level of production, yield is the number of fish that can be harvested that are in excess of the number of fish required, on average, to replace the production in the next generation.

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Appendix 7 - Chronology of Highlighted Activities

The following series of brief points is intended to provide a quick reference to the background, events, activities and output of the Council:

January 1995
The report of the Fraser River Sockeye Public Review Board proposed that "...an independent Pacific Fisheries Conservation Council should be established to act as a public watchdog for the fishery." It cited the lack of credible information being made available about the status of salmon stocks and habitat conditions.

July 1997
The Governments of Canada and British Columbia signed an agreement that included the plan to create a jointly sponsored council to provide ministers with advice on "...conservation and long-term sustainable use of salmon resources and habitat." It provided for both governments to appoint members and share operating costs.

September 1998
Establishment of the Pacific Fisheries Resource Conservation Council was announced by Fisheries & Oceans Canada minister David Anderson as a unilateral federal government decision. The Chairman and Council members were selected by the Minister who expressed his hope that the BC Government would eventually participate.

October 1998
The Council began to establish its terms of reference, define its initial studies and decide to direct its reports and recommendations to both levels of government and the public.

November 1998
Council members began to draft their annual report and a series of background papers.

January 1999
Public consultations were held with several stakeholders in Vancouver.

February 1999
Another round of consultations was held to identify issues to address in the annual report.

June 1999
The SFU *Speaking for the Salmon* workshop was co-sponsored by the Council and chaired by John Fraser.

June 1999
The Council issued its *1998-1999 Annual Report*, calling for better coordination between federal and provincial governments to protect biodiversity and habitat. It called for investment in better monitoring of escapements and stock productivity to enable a focus on mitigating the higher-risk salmon impacts. The report also strongly endorsed the measures being taken to protect endangered coho stocks.
Also released at that time was a compilation of four background reports:

- *"Freshwater Habitat"* (Angelo and Rosenau) this provided an overview of habitat issues and provided extensive information about the organizations and programs related to habitat restoration and protection.
- *"Coast-Wide Coho"* (Routledge and Wilson) this report looked in detail at the stock status of coho in the province, and identified the high-risk areas and particular challenges associated with coho restoration.
- *"Fraser River Sockeye"* (Routledge and Wilson) the status of sockeye stocks, the staple of the Fraser River's higher-value fishery, was reviewed and assessed.

- *"Salmon Stocks"* (Walters and Korman) the broad directions of salmon stocks across the province were identified in this report that also indicated where serious information voids and particular problems, including those related to escapement and pre-spawning mortality, existed.

July 1999
The Chairman met with Fisheries Minister Anderson, requesting a restructuring of the Council's administrative arrangements and a reconsideration of the budget in light of the lack of a financial contribution by the BC Government.

August 1999
An extensive presentation to the Council was provided by Donna Petrachenko and federal government officials in response to the Council's annual report. Later in the month, a statement and news release were issued by Council members concerning the stocks at risk, particularly Thompson River and Upper Skeena coho.

October 1999
A one-day conference on climate change at SFU Harbour Centre was sponsored by the Council, involving workshop presentations and public participation in discussions.

November 1999
Public consultations were held in Campbell River and Kamloops.

December 1999
Public consultations and workshop participation were held in Terrace and Prince Rupert.

January 2000
The Council released the publication entitled *"Climate Change and Salmon Stocks"*, summarizing the conference proceedings and providing a statement by Council members, particularly their observations and findings about the significance of climate on salmon prospects.

February 2000
A workshop was held with selected government and stakeholder representatives to discuss the draft report by Randall Peterman on the Pacific Salmon Treaty. Later that month, public consultations in Vancouver with environmental NGO's and sports fishing representatives in preparation for the annual report

March 2000
An SFU conference on aquaculture, sponsored in part by the Council, was held in Vancouver.

April 2000
The Council met with fisheries stakeholders and government officials to discuss the proposed wild salmon policy statement, and began to formulate its position on the issues. A briefing was also held to review the BC Government's aquaculture positions.

May 2000
The Council held a two-day retreat on Vancouver Island to discuss the direction they should take, and to establish priorities for activities and reports.

June 2000
The report entitled *"The Wild Salmon Policy and the Future of the Salmonid Enhancement Program"* was released, outlining the Council's views on the policy-making procedures that led to the report, as well as comments on the proposed policy. It expressed a concern that the proposed principles were not sufficiently strong in setting a conservation priority, nor were they consistent with the precautionary approach.

June 2000

The *1999-2000 Annual Report* was released at an event in Robson Square. It explained that salmon catches and many stocks were at their lowest levels of abundance in nearly a century. It suggested initiatives in the continuation of fishing restrictions and more comprehensive monitoring of depressed stocks.

Also unveiled were four more background papers:

- *"Water Use Planning: A Tool to Restore Salmon and Steelhead Habitat in British Columbia"* (Angelo and Rosenau) This report chronicled the several agencies and activities in water management.
- *"Review of the Coho and Chinook Salmon Sections of the "Agreement Under the Pacific Salmon Treaty" between Canada and the United States, dated 30 June 1999"* (Peterman and Pyper) This report provided a balanced assessment of the treaty and its impacts, and projected the longer-term consequences.
- *"Sand and Gravel Management and Fish-habitat Protection in British Columbia Salmon and Steelhead Streams" (Angelo and Rosenau)* This technical review of river and salmon conditions related to gravel extraction and construction.
- *"State of Salmon Conservation in the Central Coast Area"* (Wood) The stock status and issues related to salmon productivity in this region were reviewed in this comprehensive report.

August 2000

Participation in discussions for the federal fisheries review of consultation processes included a meeting with the project leader, Stephen Owen.

September 2000

Participation in the work of the BC Government's Aggregate Advisory Panel consisted of a meeting with the Chair and a follow-up letter explaining the Council's recent background paper findings.

October 2000

The Okanagan tour of facilities and meetings included discussions with First Nations representatives and the Council's commitment to facilitate contacts with both levels of government.

December 2000

This month marked the completion of the term of service for all Council members.

March 2001

Distribution of advisory paper entitled *"Salmon Conservation in the Central Coast"* took place during the month.

April 2001

The re-appointment of some Council members and announcement of three new members was made by Fisheries & Oceans Canada minister Herb Dhaliwal. The members established their new workplan and agreed to proceed with two reviews requested by Minister Dhaliwal.

August 2001

Members met with their counterparts from the east coast Fisheries Resource Conservation Council to compare their approaches and explore possible joint activities. A series of meetings was initiated with the federal government liaison to begin resolving some administrative and procedural matters, as well as exchange information on emerging issues.

September 2001

Activities included the distribution of two advisories. The first, entitled *"A Crisis in Fisheries Education"* (LeBlond) provided perspectives on the shortcomings of current educational, training and employment opportunities in the fisheries, and identified the emerging skill sets required for future scientific and management activities. The other, entitled *"The Role of Public Groups in Protecting and Restoring Freshwater Habitats in British Columbia, with a Special Emphasis on Urban Streams"* (Angelo and Rosenau) explained the effect of voluntary efforts in salmon restoration projects and advocacy, and put forward some case studies of effective habitat organizations.

November 2001
A presentation by the Chairman to the Leggatt Enquiry, stressing the importance of aquaculture policies that account for impacts on wild salmon, also involved the suggestion that common ground be developed to enable aquaculture to co-exist with wild salmon populations.

December 2001
The 2000-2001 Annual Report was completed and distributed. It emphasized the significance of ocean conditions in the salmon lifecycle, and suggested that recent improved salmon returns may be temporary and largely due to exceptionally productive ocean feeding.

January 2002
An advisory letter to Minister Robert Thibault on late-run Fraser River Sockeye stocks proposed an extensive research program to identify the problems and test solutions to halt the pre-spawning mortality.

February 2002
A consultation session was held in Victoria to review the most recent annual report and discuss the Council's activities and direction.

April 2002
In a speech to a major ecosystem and fisheries conference in Spokane, the Council Chair explained the Council's views on conservation and restoration, particularly in the Okanagan.

May 2002
The Council's views on Fraser River sockeye were explained to the House of Commons fisheries committee by Murray Chatwin who called for new research funding to find the causes and mitigate the devastating mortality levels.

July 2002
New staffing and administrative arrangements were put into place to reduce the Council's overhead costs and re-allocate funds into salmon studies and projects.

August 2002
An independent fact-finding review of the issues related to aquaculture and wild salmon was initiated by the Council.

In addition to the activities outlined above, the Council has participated in several meetings of the PSARC, as well as other fisheries seminars and conferences. The Chair has presented speeches to audiences throughout the province and elsewhere during the past three years, explaining the Council's role and positions on key issues.

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